RESEARCH CORPORATION *for* SCIENCE ADVANCEMENT

A foundation dedicated to science since 1912.

risk and reality

2011 Annual Report

science = risk

The world requires more aggressive basic science research to address complex issues.

James M. Gentile
President and CEO

Commentary by James M. Gentile

In 2011, its 99th year of existence, Research Corporation for Science Advancement (RCSA) remains a strong proponent of collaboration and community in the realm of academic-based inquiry in science: We believe that science, humankind's most audacious collective endeavor, has, of necessity, become a team sport. Furthermore, we believe that audacity itself—in the sense of boldness, the confidence to take risks, and the trust and belief in one another—is increasingly essential among scientific collaborators due to the enormity and complexity of the many global challenges they are being called upon to address.

There is urgency to our situation: The underdeveloped world's population is projected to increase by 2.9 billion by 2050, compared with only 49 million in the more developed countries. This growth is likely to add exponentially to problems of health maintenance as well as disease control. In addition, already, of the seven billion people on this planet, 854 million, or 12.6 percent of the world's population, are undernourished, according to the United Nations Food and Agriculture Organization. Of that number, 820 million are thought to be in underdeveloped countries. In many of these areas today, clean water is already in short supply.

Add to the food and water problems the fact of peak oil and the growing need for renewable energy. Globally, we must go from roughly 15 billion terawatts peak rate of energy production today (with 80 to 90 percent derived from fossil fuel combustion) to roughly 30 billion terawatts by 2050, according to energy chemist Nathan S. Lewis, of the California Institute of Technology. Thus it becomes starkly obvious; The world requires more aggressive basic science research to address complex issues.

Arun Majumdar, Director of the U.S. Department of Energy's Advanced Research Projects Agency–Energy (ARPA-E) has put this situation in perspective for one aspect of the need for accelerated scientific and technological innovation. He spoke at a 2010 Scialog Conference sponsored by RCSA. According to Majumdar:

"*During the 20th century, certain key innovations changed the course of human history, including the Haber-Bosch process of creating artificial fertilizers by fixing atmospheric nitrogen to form ammonia. It touched humanity like none other because it led to massive increase in food production and an almost fourfold increase in global population in 100 years. Other game-changers included creating semi-dwarf, high-yield strains of wheat that introduced the green revolution; and, antibiotics; polio vaccination; the transistor and integrated circuits; electrification; the airplane; nuclear energy; optical and wireless communication; the internet; and more. Now imagine all of these innovations happening in the span of just 10 to 20 years. That is the scale and pace of the game-changing innovations that we need to address the energy and climate change challenge we face. In short, the next 20 years need to be the most innovative period in our Nation's history.*"

Investing in Collaborations

In 2011 the Foundation took bold steps by investing in interdisciplinary collaborations that may one day—and, it is hoped, sooner rather than later—yield big pay-offs. The world requires collaboration because, as science philosopher Karl Popper has observed, the problems we face "cut right across the borders of any subject matter or discipline." Much has been said about interdisciplinarity in the past few years. Joaquin Ruiz, dean of the University of Arizona College of Science, puts it in a nutshell:

"*What has happened since science came from natural philosophy is that the problems were very big and so we started atomizing our approach to knowledge so*

> …we've atomized our knowledge so much that we don't have the tools to really address these major questions that are broader than our own disciplines.

that we could understand what was going on. We became specialists in an attempt to really understand things. But now we recognize that in many cases we've atomized our knowledge so much that we don't have the tools to really address these major questions that are broader than our own disciplines."

My own field of environmental genetic toxicology, which had its official beginnings in 1965, draws from numerous disciplines. Our initial research, for example, focused on the role of metabolism in the conversion of natural and xenobiotic agents into mutagens and carcinogens, allowing us to define the processes by which plant systems use their unique biochemistry to metabolize agents into carcinogens that can affect humans through food, soil and water.

A field of study broaching at once plants, animals, humans and cancer, would, at one time in the recent history of science, have seemed to be an exercise in fervid eclecticism at best, and sheer lunacy at worst. However, over the centuries, decade by decade, scientific research has produced new and ever more powerful paradigms—schemas for the organization of perception, knowledge and intellectual exploration that enable scholars to more deeply understand nature. In particular, environmental genetic toxicology—and many other areas of study in science—owes its existence to a central paradigm of modern biology—genetics, and Watson and Crick's elucidation of the DNA double helix in 1953.

As Ruiz puts it, "Basically, everybody in science is now onboard with the idea that the big problems, and their potentially transformative solutions, are not within any one discipline." In 2003, for example, the W.M. Keck Foundation formalized support for its Futures Initiative, in conjunction with the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The program's goal is to stimulate new modes of scientific inquiry and break down barriers to interdisciplinary research in funding agencies, academic and other research settings, publication and academia." In 2009 the Bill and Melinda Gates Foundation announced it was creating a Grand Challenges Exploration to "promote badly needed cross-disciplinary solutions to disease and prevention in all areas of the world."

Supporting Mutualistic Teaming

What RCSA sees as the required nature of interdisciplinary collaboration in the face of major global challenges may differ somewhat from the currently accepted model of collaboration in the physical sciences. Our long-term goal has been to produce the kind of collaborative model best annunciated by RCSA Presidential Advisor Robert Full, Chancellor's Professor in the Department of Integrative Biology at the University of California, Berkeley.

Full has coined the term "mutualistic teaming" to describe a unique form of interdisciplinary collaboration. Full said, *"We began by being too disciplinary. That was because we wanted people to have depth. And then we made another error on the other extreme by trying to push individuals to learn a lot about the other disciplines. We were then creating a person who was a sort of jack-of-all-trades, master-of-none who really couldn't contribute to the interdisciplinary collaborations because they had insufficient depth… We failed for many years because we didn't understand this process fully."*

Eventually, he created a research-based teaching lab that brings together teams of graduates and undergraduates, biologists and engineers.

"It's not a cookbook lab with low-tech equipment where everybody gets the right answer," Full said. He added that the program's goal is to take participants through the steps of critical thinking outlined by the late Harvard education psychologist William G. Perry, Jr. At the heart of Perry's schema is the mature intellect's ability to recognize conflicting versions of "truth" as representing legitimate alternatives. Full outlines how this plays out in his teaching lab:

"The interdisciplinary team has six hours to solve a problem. They never get the answer we told them in class or that they read in the textbook. They have to then deal with the first hurdle in critical thinking, which is uncertainty. And then in the next block, they get to change the experiment a little bit. Not a lot, because these are set up already; but in doing so they confront for the first time real issues of mutualistic teaming. The biologist might say, "What can the engineers give me that could help me answer this biological question? Oh, they have new ways to measure things, they have wonderful quantitative hypotheses that I can learn. They have methods of data analysis that I haven't used, but I'm interested to see what the capabilities are. I'm interested to work with them on that and to try to define our questions." So they clearly see what they can contribute and what they get back. And the engineers now do the same thing. They say, "I don't even know about what problem we're addressing. I don't understand what the organism is or what it can do, but I see I can help answer these questions. And then once I do that, I get inspiration for designing new robots, control algorithms, whatever I'm interested in that I would never have gotten without teaming with a biologist."

In mutualistic teaming each discipline reciprocally advances the other, allowing collective discoveries to emerge beyond any single field. This concept of mutualism differs from the traditional concept of interdisciplinary research in the physical sciences, which is still seen largely as the temporary subsuming of various experts to solve a problem mainly within the purview of a specific discipline. Also, while mutualism allows for the interplay of distinct paradigms, it is simultaneously pointing to the co-evolution of these paradigms into a sum that is greater than its parts.

"It's learning from one another, if you call it a class, and it's communication if you're doing it with more senior people in these interdisciplinary research collaborations," Full said. "But now I see that learning and communication are starting to be one thing here."

In the Poly-PEDAL Lab that Full heads at Berkeley, this co-evolution process is leading rapidly toward a new science of biological engineering that today enables robots to climb walls like geckos. Tomorrow this emerging science may give our soldiers superhuman powers in battle and our construction workers astonishing skills for building cities on the moon.

In short, RCSA looks to mutualistic collaborations to move us beyond the global challenges we now face and to conceive of solutions we have not yet dreamed that we require. This is RCSA's vision of science advancing at warp speed, and in 2011 the Foundation took a number of steps toward making it a reality. This report outlines our 2011 activity.

RCSA continued its visionary Scialog program, which encourages high-risk/potentially high-reward collaborative research.

Scialog is an experiment to see if we can accelerate the pace of breakthrough discoveries, initially in solar energy conversion. The program rewards risk-taking in science, even if failure is a significant possibility. Time and again we have seen that it is the people who push the limits of what we think we know who come up with the tools and knowledge we need to achieve our greatest advances.

The October 2011 Scialog Conference held at Biosphere 2 north of Tucson, Arizona, drew more than 60 scientists from around the nation. Keynote speakers included Dan Arvizu, Director and CEO of the National Renewable Energy Laboratory; Nathan Lewis, Professor of Chemistry at Caltech and Director of the federally funded Joint Center for Artificial Photosynthesis; James McCusker, Professor of Chemistry and Associate Chair for Research, Michigan State University, a world authority on ultrafast excited-state dynamics of transition metal complexes; Thomas Peterson, Assistant Director, Directorate for Engineering at the National Science Foundation; and Krishnan Rajeshwar, Associate Dean, College of Science, University of Texas at Arlington, and a founding director of the Center for Renewable Energy Science & Technology.

The heart of the Scialog program is the conference discussions, which create a special stew of people, perspectives, knowledge and process leading to interactions that generate creative energy. Scialog discussions were led by Elizabeth McCormack, Professor of Physics at Bryn Mawr College.

RCSA and Education

Fundamental to the successful continuation of the basic enterprise of science is the spirit and the act of collaboration in the task of educating America's next generation of scientists.

In academia, barriers to interdisciplinarity in teaching and in research continue to be enforced at the department level (although increasingly informally in some institutions). In teaching related to the professional disciplines especially, the accrediting societies play a major role in holding the disciplinary lines, observes Orlando L. Taylor, president of the Chicago School of Professional Psychology's Washington, DC, campus.

"If you look at the applied fields, like engineering, for example, there are often accrediting requirements that compromise the capacity for interdisciplinarity," Taylor says, though he adds that is increasingly less of a problem for mathematics and the basic sciences like chemistry and physics. This is very good news.

Meanwhile, in related matters, during October 2011 the Association of American Universities (AAU) announced that it was beginning a five-year initiative to improve science, technology, engineering and mathematics (STEM) education. The goal: *To work together in a coordinated fashion with higher education associations, individual universities, disciplinary societies, federal agencies, and the business community to bring about improvements that help our students, and our nation, meet the challenges of tomorrow.*

AAU membership is composed of 61 major research universities, 59 of which are in the U.S. The National Academy of Sciences issued its powerful warning of America's chronic STEM-education disaster, *Rising Above the Gathering Storm*, in 2007 (and an even gloomier follow-up report in 2010). And there have been numerous, and nearly as alarming, white papers and reports for several decades. AAU President Hunter Rawlings said in a September 16, 2011, article by Jeffrey Mervis in *Science* that the AAU's discussion draft notes that most students who leave STEM do so during their first two years of college, and that "those years are especially critical in terms of teaching." It states that "improving teaching will require cultural change." The current culture, it adds, has been created by the research universities partnership with government. Robert Mathieu, from the Center for the Integration of Research, Teaching, and Learning (CIRTL), observes that "external [research] funding plays a major role in defining importance and legitimacy."

The draft touches on the very heart of the matter when it cites results from a recent survey by *Nature* that found 41 percent of responding faculty members "felt that their institutions valued research more than education."

The AAU's initiative to improve STEM teaching will apparently rely on four main strategies, according to the draft: **1** disseminating curricula and pedagogy; **2** developing reflective teachers (defined as those who use their own knowledge/experience/skill to improve their instructional practices); **3** enacting policy (including incentives and quality assurance measures); and **4** developing shared visions (including departmental-level collaboration and institutional-level actions.)

As America's second-oldest foundation, RCSA has been concerned with issues surrounding STEM and the quality of undergraduate education for many years now. In 1994, in an effort to directly address the challenge of improving the quality of science instruction at research universities, the Foundation created the Cottrell Scholar Awards (CSA) program. The program is named in honor of Frederick Gardner Cottrell, scientist, inventor and philanthropist. Cottrell founded Research Corporation in 1912 and provided means for scientific research and experimentation at scholarly institutions. Not only did he contribute fundamentally and practically to scientific knowledge, but he dedicated his career to enlisting science in the service of society.

Those selected by peer review for CSA honors represent the nation's top young teacher-scholars. They have both excellent research programs and excellent approaches to student learning at the undergraduate level.

> Numerous studies have shown that the undergraduate programs most successful at producing scientists are those that include research and publication.

The Importance of Undergraduate Research Institutions

The AAU's Rawlings has noted that "we've had enough experience with undergraduate research programs to understand that students are more likely to become scientists if they are actively engaged in research." This has been RCSA's position for decades now, based on the first-hand observations of generations of the Foundation's program officers as they have paid countless visits to our nation's primarily undergraduate institutions (PUIs), the public and private liberal arts schools.

Furthermore, over the past 10 years, according to RCSA program officer estimates, the Foundation's grants have supported the real world research work and active learning of roughly 5,000 undergraduates. RCSA's Cottrell College Science Award (CCSA) program, aimed at PUIs, is responsible for the bulk of this total, with roughly eight students benefitting for every CCSA grant made. [See page 18 for 2011 CCSA awards.]

And RCSA certainly hasn't been shy about promulgating the message that undergraduate research is the best type of science education. In 1978 Foundation personnel were instrumental in the creation of the Council on Undergraduate Research. CUR, which supports and promotes high-quality undergraduate student-faculty collaborative research and scholarship, has a membership of 4,500 individuals and nearly 600 colleges and universities.

Robert M. Gavin, president of the Cranbrook Education Community, and a past president of Macalester College, was quoted in RCSA's influential 2000 report on highly effective PUIs, *Academic Excellence:*

"Numerous studies have shown that the undergraduate programs most successful at producing scientists are those that include research and publication in refereed journals. That is, research activity helps the faculty keep current but it also leads to more positive results for the students. Often the defenders of research by the faculty are accused of not being concerned about students. The studies demonstrate, to the contrary, that the students benefit from a research-based teaching environment. Students who have the opportunity for research complete their science programs in greater numbers than those who do not. That implies to me that what is good for the faculty is also good for the students."

In addition S. Frederick Starr, president of Oberlin College (1983-1994) and organizer of the 1985 Oberlin Conference attended by presidents of the nation's top 50 colleges of arts and sciences, the so-called Oberlin 50, noted in a summary of that event, subsequently quoted in *Academic Excellence:*

"The primary hallmark of undergraduate science education at the participating liberal arts institutions was the faculty-student interaction which afforded the opportunity for students to do research alongside a distinguished faculty member."

The Oberlin 50 met in June 1985 and June 1986 at Oberlin College. Reports from these events are still being cited today:

"The report of these conferences argued that baccalaureate colleges had been prolific sources of scientists and called for more federal and nonfederal support for research at undergraduate institutions," according to the 2008 NSF report, *Baccalaureate Origins of S&E Doctorate Recipients*," by Joan Burrelli, Alan Rapoport and Rolf Lehming.

According to the authors of the NSF report, baccalaureate colleges graduate relatively small numbers of undergraduate degree holders compared to doctorate and master's-granting institutions. However, when normalized by the number of bachelor's degrees awarded, the baccalaureate colleges as a group yield more future S&E [science and engineering] doctorates per hundred bachelor's awarded than other types of institutions, except research universities. A group of 50 small, private baccalaureate schools (the Oberlin 50) was studied in the mid-1980s and was found at that time to contribute greatly to producing future S&E doctorates. These schools have long out-produced (by yield) even the research universities.

The achievements of the PUIs in contributing to the next generation of America's scientific workforce are admirable. Nevertheless, it is the position of the Foundation that in a rapidly expanding global economy with increasing competition in science and technology, the baccalaureate colleges, like the research universities, cannot rest on their laurels. That is why, in 2009, RCSA instituted an experimental grant in the long-running CCSA program, the CCSA-Multi-Investigator Award. Encouraged by the response among a handful of initial grantees, in 2011, we continued to expand the CCSA-Multi, and the Foundation's scientific staff has begun discussions on the feasibility of adding a convening function to the CCSA program, much like the annual Cottrell Scholars conference.

The primary goal in both the CCSA-Multi and discussions of a possible convening is to build and strengthen communities in science. Initial anecdotal results with the CCSA-Multi indicate the intended effect is occurring.

For example: Kevin L. Caran (James Madison University Chemistry & Biochemistry); Kevin P. C. Minbiole (Villanova Chemistry, formerly JMU); and Kyle Seifert (JMU Biology)—2009 CCSA-Multi awardees, wrote:

"Our fruitful collaboration was spawned by the announcement of the 2009 RCSA Multi-Investigator Cottrell College Science Award (CCSA-Multi). Two of us (KC & KM, "the chemists") had collected preliminary data suggesting that some of our novel multi-headed amphiphiles were antibacterial. The provision in the CCSA-Multi grant requiring principal investigators to come from multiple departments aligned well with our need for a microbiologist. This stimulated a trip across campus to the biology building where we recruited the final member of our team (KS, "the biologist"). We quickly realized a shared vision that took advantage of our diverse backgrounds, and subsequently submitted a successful CCSA-Multi application. Our ongoing collaboration has resulted in the publication of a full paper in the *European Journal of Medicinal Chemistry* that includes ten undergraduate coauthors along with the three PIs. Several additional collaborative publications are in the pipeline, and a follow-up proposal was recently submitted to the National Institutes of Health (R15 AREA). In addition to inspiring our collaboration, the RCSA funding has also provided support for a significant number of undergraduate student researchers in all of our labs, many of whom continue to work as part of this interdisciplinary team. We are greatly indebted to Research Corporation; it is likely that our collaboration never would have developed without their support."

The CCSA-Multi is, first of all, an attempt to end the isolation that afflicts many individual researchers at PUIs. A researcher in a small school often finds herself isolated not only geographically but also professionally, as, for example, the only organic chemist at that institution. The award offers a way to bring scientific faculty together, and helps them realize they are contributors to the larger community of scientists. Secondly, the award encourages those who do the hiring at PUIs to think strategically about the need for new faculty to complement the existing scientific roster. It is also aimed at encouraging administrators to look beyond individual accomplishments when reviewing promotion and tenure packages and to pay some attention to team-oriented activities. Finally, and perhaps most importantly, the CCSA-Multi gives students the opportunity to assist in real-world research that is multidisciplinary; and, it is our profound hope, it encourages students and researchers alike to develop new and innovative ways of approaching tomorrow's complex problems.

The Tip of the Spear

It is the contention of the Foundation, as well as other organizations such as the National Academies, and now the AAU, that findings such as these by the NSF must be weighed and acted upon in the context of current, very threatening, global trends. For an eye-opening jolt, see the competitive indicators included in the *Gathering Storm* report. Here are just a few from that long list:

Research Corporation for Science Advancement hereby commits to forging and throwing the first spear in this 21st-century battle.

- *It has been estimated that within a decade nearly 80% of the world's middle-income consumers would live in nations outside the currently industrialized world. China alone could have 595 million middle-income consumers and 82 million upper-middle-income consumers.*
- *Chemical companies closed 70 facilities in the United States in 2004 and tagged 40 more for shutdown. Of 120 chemical plants being built around the world with price tags of $1 billion or more, one is in the United States and 50 are in China.*
- *No new refineries have been built in the United States since 1976.*
- *A company can hire eight young professional engineers in India for the cost of one in America.*
- *The share of leading-edge semiconductor manufacturing capacity owned or partly owned by United States companies today is half what it was as recently as 2001.*
- *During 2004, China overtook the United States to become the leading exporter of information-technology products, according to the Organisation for Economic Co-operation and Development (OECD).*

Some economists have estimated that about half of U.S. economic growth since World War II has been the result of technological innovation, according to the National Academy. Emerging nations like China and India now understand full well America's "secret" of success. Put simply, if we hope to compete in tomorrow's global economy, the general consensus seems to be that the United States must increase the quality of STEM education in the vast majority of its baccalaureate colleges as well as its public universities, bringing the effectiveness of instruction to the level found in our top private institutions. We must do this because, ultimately, our prosperity and our collective security depend on producing the next generation of the world's best and brightest scientists.

Unfortunately, the academic community excels at conducting studies and issuing white papers. It fails miserably—and repeatedly—when it comes to taking widespread, coordinated action. It is as if the native inhabitants of this particular archipelago are fond of beating their drums to warn of the approaching sea monster. But somehow all of this urgent communication among the islands never transforms into a comprehensive, concerted attack on the collective threat. Given the recent revival among some politicians of the practice of "proxmiring" NSF-funded, peer-reviewed scientific research, as well as Congressional gridlock and continuing petty budget battles, there is most assuredly no taxpayer-funded rescue armada steaming this way.

We in the academic-based science community must rise to the challenge on our own.

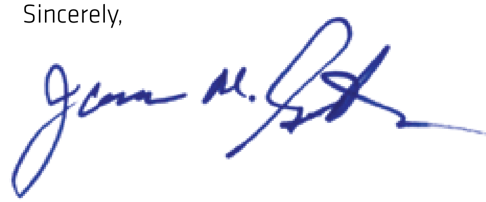
That is why RCSA hereby commits to forging and throwing the first spear in this 21st-century battle. As a small, independent foundation, we are nimble and aggressive where larger agencies and government are cautious and seemingly endlessly deliberative. As our 99-year history demonstrates, we recognize the problem/opportunity and we take action: RCSA funded Robert Goddard at a critical time in his research, giving rise to modern rockets; the Foundation was quick to support Ernest Lawrence's dream to build the first big cyclotron, opening the door to subatomic physics; through its Williams-Waterman Fund RCSA all but eliminated the dietary scourges of pellagra and beriberi. We have accomplished much more besides, despite our small size.

In keeping with this tradition of action, by the fourth quarter of 2012, RCSA pledges to have rallied our sister foundations and like-minded organizations for a frontal assault on the current stumbling blocks impeding top-quality science education in the majority of United States colleges and universities. This task will require overcoming resistance in our universities to the ideal of the dedicated teacher-scholar as the central powerhouse of United States science advancement, and it will also require making an honest start at implementing widespread and effective undergraduate research programs in our colleges and universities.

Of course we will also continue to fund the high-risk/potentially high-reward research that may lead to the breakthrough discoveries America will need to prosper in the coming decades.

Please join us in this audacious and vitally important effort.

Sincerely,



James M. Gentile
President & CEO
Research Corporation for
Science Advancement

Scialog is a critically important experiment in collaboration and community-building as a means to accelerate urgently needed transformative science.

scialog

Scialog seeks to accelerate the work of 21st-century transformational science through funding research, intensive dialog and community building. Each multi-year initiative promotes scientific innovation in the face of a complex research challenge that serves as a driver in contemporary science. Successful grantees are asked to address a few narrowly focused issues on a particular research initiative and to communicate with one another in an annual closed conference for the purpose of sharing insights and building further collaborations.

Facilitated dialog is used to break down traditional barriers to authentic communication, to identify bottlenecks to the research initiative, and to encourage innovative approaches to transformative breakthroughs.

These meetings are intended to advance human knowledge by building and strengthening a nationwide community of scientists, many of whom have many promising years of research ahead of them. Through the give-and-take of community building, it is the Foundation's hope that Scialog participants will be better equipped to tackle even more challenging problems in the future. Success among initiative participants is measured in terms of subsequent partnerships formed and how research clusters intersect with others in the academy, with the private industrial sector and with the federal sector to continue promising lines of research that ultimately lead to true scientific breakthroughs.

Scialog is intended to: **1** support early-career faculty to expand research in a specifically focused area determined to be urgently important for the nation's welfare; **2** encourage scientists to form collaborative cross-boundary or interdisciplinary teams to tackle the critical areas identified by RCSA, and; **3** help transition awardees to future funding.

The Scialog process is guided by a panel of nationally recognized scientists chosen from the research, scholarly and science-policy communities.

With recent policy reports and RCSA's 2005 annual report pointing to an evolution in modern research toward greater complexity, it is incumbent upon funders, both public and private, to seek bold and innovative ways to advance human knowledge toward these ends. As Brandeis University Professor Gregory A. Petsko noted in the 2005 RCSA annual report, interdisciplinary institutes are still considered experimental: "Anybody who tells you they know how to do it right is fooling themselves... We've got to do a lot more, because we don't know what models work..."

Thus, the Scialog initiative is a critically important experiment in collaboration and community-building as a means to accelerate urgently needed transformative science. And because we regard it as an experiment, RCSA scientists are actively involved in assessing all aspects of the initiative, including making site visits to successful grant recipients, in order to better understand both the research progress and "what works" in building collaborations and community.

Because reliable sources of renewable energy are vitally important for U.S. security, global stability, and a sustainable future, Research Corporation for Science Advancement has chosen to address the issue of solar energy as its first initiative under the Scialog program. The Scialog Collaborative Awards are a radical example of RCSA's commitment to transformative research. This year's Solar Energy Conversion Awards and $100,000 Collaborative Awards are listed on the following pages.

Scialog Solar Energy Conversion Awards

Ronald K. Castellano
Associate Professor of Chemistry
University of Florida

Jiangeng Xue
Materials Science Researcher
University of Florida

A Modular Supramolecular Approach to Organic Photovoltaic Materials

Perhaps someday, if chemist Castellano and materials scientist Xue are successful, the grass in your front yard will never need mowing because it is inexpensive artificial turf. Even better, it will also generate enough electricity to power your home. The researchers are working in organic photovoltaic materials—basically cheap plastics that generate electricity when exposed to sunlight. (They are called "organic" because of the presence of carbon atoms, the building blocks of life.) The duo's goal is to make these relatively inefficient materials much more efficient at generating electricity than they are today.

Daniel R. Gamelin
Professor of Chemistry
University of Washington

David S. Ginger
Professor of Chemistry
University of Washington

Dopant-carrier Auger De-excitation as a New Approach to Multi-threshold Solar Conversion Devices

Gamelin and Ginger, both chemistry professors, are taking an innovative approach to the already highly innovative technology of quantum dots. Through their experiments on the edges of chemistry and materials science, they hope to increase the voltage of the electrical energy we can generate with sunlight. Boosting the voltage produced by a solar panel composed of quantum dots could help to reduce the overall size of the panel. Their research strikes at the very center of how advanced technology currently views and uses quantum dots.

So Hirata
Professor of Chemistry
University of Illinois at Urbana-Champaign

Computational Discovery and Optimization of Organic Photovoltaic Materials

Hirata, a computational chemist, is bringing his talent for innovation to the vital work of creating cheap and efficient materials to generate electricity from sunlight. Hirata is creating advanced computational algorithms—sets of mathematical instructions for carrying out a procedure or solving a problem—to theoretically predict the optical and electronic properties of a class of advanced polymer materials used to transform the way energy is generated or used more efficiently.

Song Jin
Associate Professor of Chemistry
University of Wisconsin

Enabling Solar Energy Conservation Using Rational and Scalable Growth of 1D Nanomaterials Made of Inexpensive Semiconductors

Jin, an associate professor of chemistry, is stretching the limits of nanotechnology. He is experimenting with nanowires—incredibly thin strands of crystals. "Nanotechnology can offer new approaches to solar energy conversion that promise higher efficiencies and lower cost," Jin said. He cautions that whatever semiconducting materials we decide to base our renewable energy technologies on "better make sense from the beginning. Otherwise we are merely turning our dependence on foreign oil into a dependence on indium, tellurium, cadmium, and other rare elements."

Darren W. Johnson
Associate Professor of Chemistry
University of Oregon

Richard P. Taylor
Professor of Physics
University of Oregon

Role of Fractal Patterns on New Materials for Solar Energy Applications: Inorganic Clusters, Films and Fractal Geometry Simulations

Physics professor Taylor and Johnson, an associate professor of inorganic, organic, supramolecular and materials chemistry, are working to determine which fractal patterns might best support highly efficient solar devices. At the same time, they will synthesize new inorganic (non-carbon-based) nanoclusters. The plan is to put these nanoclusters into inks, which will allow the researchers to print, perhaps via inkjet printers, relatively inexpensive devices to convert sunlight into electricity. Ultimately, they hope to print in fractal patterns that mimic, or even improve upon, the light-harvesting patterns found in nature.

Sean Shaheen
Associate Professor of Physics
University of Denver

Energy Pooling as a Novel Thermodynamic Mechanism for Organic Photovoltaics

Shaheen, a physicist, hopes to greatly reduce, or even eliminate, the need for expensive minerals and complicated manufacturing steps, all while improving the electrical properties of cheap plastic panels. He will try to do so through a phenomenon called "energy pooling." Basically, this pooling effect occurs when a number of excited electrons are collected in a single spot on a molecule. Shaheen predicts that pooling will increase a solar panel's voltage (potential for energy), while reducing the proportional energy loss (as heat) inherent in the process of electrical current production. He hopes to do this by carefully adding "plasmonic nanostructures" to the plastic; these structures create quasi particles called plasmons when photons are jammed into tiny spaces, causing their energy to excite nearby electrons.

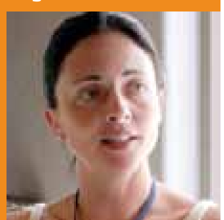
Lei Zhai
Associate Professor of Chemistry
University of Central Florida

Investigating Chare Transport and Recombination in Bulk Heterojunction Organic Photovoltaics with Conjugated Polymer Columnar Structures on Graphene

Zhai, associate professor of chemistry and nanoscience, is deeply involved in the race to produce cheap, effective solar devices. He hopes to achieve this by radically improving efficiencies in what solar researchers call bulk heterojunctions—basically a mixture of two dissimilar semiconductors with enormous interfacial area between these two materials. Zhai's work involves adjusting relatively inexpensive carbon-based semiconductors to get them to produce electricity. To achieve his "dream outcome" of a sprayable, power-generating liquid, he is combining and then testing many variations of fullerenes and polymers.

Scialog Collaboration Innovation Awards

Hugh Williams Hillhouse



Janelle M. Leger

Lei Zhai

Richard P. Taylor

Sean Shaheen

Associate Professor of Physics
University of Denver

Raymond K. Kostuk

Professor of Engineering and Optical Sciences
University of Arizona

Christine K. Luscombe

Assistant Professor of Materials Science and Engineering, University of Washington

Holographic Spectrum Splitting for Multijunction Organic Photovoltaics

Photovoltaic cells that produce electricity from sunlight only convert a small percentage of incident sunlight into electricity. One way to make them more efficient is to stack their "junctions," the areas that do the actual work of converting sunlight to electricity, on top of one another. Junctions are sensitive to specific colors in the spectrum of visible light: some junctions are sensitive to red light; some are sensitive to blue; others are sensitive to the other colors that make up sunlight. Some solar devices with stacked junctions already exist, but they are very expensive, which means they are used mostly on orbiting satellites and other important projects. This team hopes to successfully deploy a special laser-cut diffraction filter based on the principles of the hologram to spread and intensify the colors in sunlight so that the junctions sensitive to different colors of light can be placed in flat rows. Their hope is that the resulting solar devices can be manufactured using "organic"—a chemists' code word for "carbon-based"—materials that are generally cheap and readily obtainable.

Frank K. Osterloh

Professor of Chemistry
University of California–Davis

Sean Shaheen

Associate Professor of Physics
University of Denver

Richard P. Taylor

Professor of Physics, University of Oregon

Boaz Ilan

Associate Professor of Applied Math
University of California–Merced

Fractals as a Promising Geometry for Enhanced Solar Energy Conversion

Fractals are naturally repeating patterns found widely in nature—from vast stretches of rugged seacoast to the finest veins in the tiniest of plant leaves. This team hopes to use branching fractals—the type found in leaves and trees—to optimize the collection of sunlight, while reducing the cost of doing so, in two different projects: 1) creating organic photovoltaic cells that rely on nanoscale fractal pathways for the direct conversion of sunlight to electricity; and 2) growing bacteria in fractal patterns to maximize the production of renewable liquid fuel.

Janelle M. Leger

Assistant Professor of Physics
Western Washington University

Christine K. Luscombe

Assistant Professor of Materials Science and Engineering, University of Washington

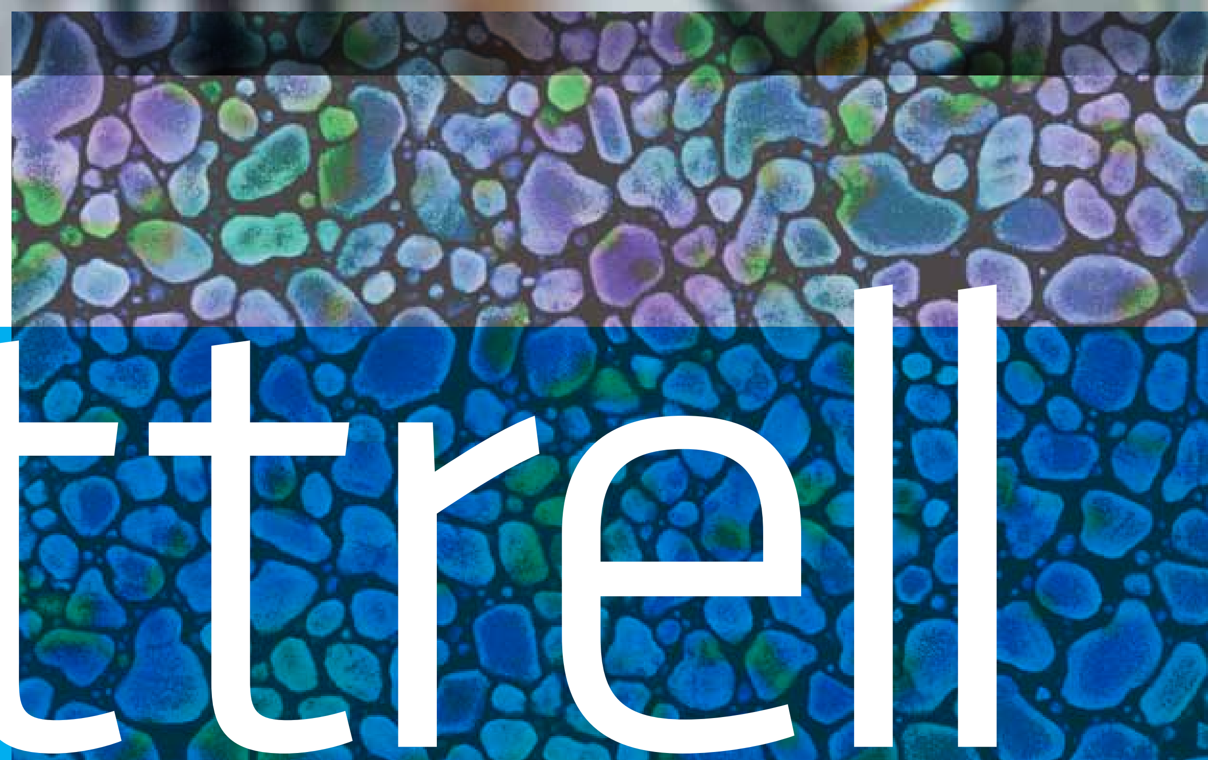
Hugh Williams Hillhouse

Rehnberg Chair Professor of Chemical Engineering, University of Washington

Novel Low-Loss Plasmonic Waveguides to Create High Efficiency PV from Ultra-Thin Organic and Low-Purity Earth Abundant Inorganic Layers

A plasmonic waveguide is a nanostructure—a very small object, smaller than the wavelength of a photon, the basic unit of light. When light hits certain types of nanostructures, photons are absorbed in a process that excites the motion of electrons at a metal surface. The result is a plasmon-polariton, or single photon coupled with a mode of oscillation of the electrons that are confined in the nanostructure. These plasmon-polaritons can therefore carry light energy in a structure that is much smaller than the wavelength of light itself. Plasmon-polaritons were first discovered at the interface of different nanostructured materials—dielectrics (material like glass or air) and noble metals (gold, silver), but these structures have so far not been able to carry light energy very far. The team hopes to create a new type of nanostructure that allows light energy to be trapped as plasmon-polaritons that can carry light energy much farther. If they can do this, the next step would be to see if the plasmon-polaritons they create can be coaxed into enhancing a thin film's ability to absorb photons. Thin-film solar panels generate electric current when electrons in the material absorb photons and become excited enough to move through the film and create electricity. If these structures can be built to oscillate at the right frequencies, they can help the films absorb more light. The result: a supercharged solar panel.

The CSA program was formulated to reinforce the growing awareness that teaching and research are complementary rather than wholly or partially exclusive.



cottrell

2011

Frederick Gardner Cottrell was the young physical chemist from the University of California, Berkeley, whose vision created RCSA in 1912. We have named several of our programs in his honor, including:

Cottrell Scholar Awards provide funds to early-career faculty in chemistry, physics, astronomy, biochemistry and biophysics at major research universities. Cottrell Scholars are chosen not only for their high-quality research, but also for their dedication to the task of teaching undergraduates.

In addition, the Cottrell Scholar Collaborative Awards, created in 2011, encourage scholars to work together to improve teaching at research universities.

Cottrell College Science Awards promote basic research as a vital component of undergraduate science education at primarily undergraduate institutions. These awards are made to the nation's top early-career researchers at public and private colleges and universities.

The main goal of the Cottrell Scholar Awards (CSA) program, which now numbers 240 Scholars nationwide, is to promote and support the university scholar model. The CSA program was formulated to reinforce the growing awareness that teaching and research are complementary rather than wholly or partially exclusive. We believe this convergence is essential for increasing the number of students who are attracted and retained in science.

Specific desired outcomes of the CSA program include: **1** A culture shift in Ph.D.-granting institutions toward valuing the university scholar; **2** Increased attraction and retention of undergraduates in science; **3** Increased undergraduates from Ph.D.-granting institutions pursuing graduate degrees.

Sarbajit Banerjee, assistant professor of chemistry at the State University of New York, Buffalo, and a 2010 Cottrell Scholar, recently noted the effects of the Cottrell Scholar Award on his professional development. His experience is not atypical:

"In many ways, the Cottrell Scholar Award has had a transformative effect on my career and my research group. The award has given me the flexibility to pursue high-risk areas of research and has enabled my students to pursue complex experiments at the world's best synchrotron light sources. The Cottrell Scholar conferences have linked me to like-minded colleagues from universities across the United States that place special emphasis on undergraduate science education and undergraduate research.

The conferences… have also provided invaluable access to mentoring from previous awardees that have freely shared their experiences with navigating their career paths and balancing research and education. The Cottrell Scholar recognition has further provided me internal leverage to push through reforms in the undergraduate chemistry curriculum and to advocate for a greater emphasis on undergraduate research and research-based courses in the curriculum."

Banerjee touches on a second key objective of the program, which is to build a community of outstanding scholar-educators who are dedicated to becoming leaders in both research and teaching and who, collectively, have the potential to change the way science is taught nationally. Traditionally, RCSA has done this by requiring Scholars to attend at least two annual Cottrell Scholar conferences while the award is active. The annual conference seeks to promote community among Cottrell Scholars and is held in early July in Tucson, Arizona.

Cottrell Scholar Collaborative

In 2011 RCSA did not make any regular Cottrell Scholar Awards; instead, Foundation personnel and various Cottrell Scholars chose to focus on revamping and reorienting the program to increase its effectiveness in the coming decade. At the 2011 conference, following six months of study by an advisory committee of six senior Scholars, a new synergistic organization, the Cottrell Scholar Collaborative, was launched.

The Collaborative's central goal is to act collectively to change the way undergraduate science education is taught at major American universities. Seth M. Cohen, University of California, San Diego, headed the formative group. Others on the committee included Teri Odom, Northwestern University; Mats Selen, University of Illinois; Rigoberto Hernandez, Georgia Institute of Technology; Jairo Sinova, Texas A&M University; and Brad Smith, University of Notre Dame.

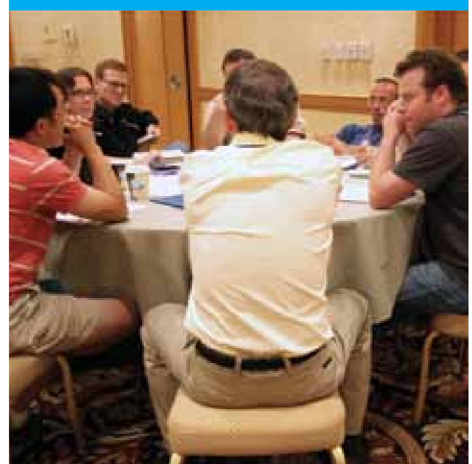
Cohen said, "I am happy to report that RCSA has been incredibly responsive to our suggestions on how to achieve our goals. With greater involvement of Cottrell Scholars in the organization and content of the Cottrell Scholar Conference this summer [July 2012], we expect to hold the most exciting and dynamic conference ever, and to continue to expand the Collaborative to new heights."

The ultimate goal is to strengthen America's community of teacher-scholars.

The Cottrell Scholar Collaborative is structured along the lines of RCSA's successful Scialog model. Scialog (science+dialog) allows everyone to participate in facilitated dialog sessions while suspending judgment. The Foundation's hope is that the end result will include some remarkable new creative approaches to the chronic problems highlighted in the AAU's draft statement.

In assessing the need for the Collaborative, organizers polled their fellow Cottrell Scholars. One question—What do you think is the greatest impediment to science education today for college?—elicited this response:

1 Uninspiring curriculum, 33%
2 Poor science and math background, 27%
3 Faculty attitude towards teaching at Ph.D. institutions, 9%
4 Societal perception of science and lack of science literacy, 8%
5 Science careers (lack of jobs; more lucrative jobs outside science), 7%
6 Lack of resources, 4%
7 Diversity issues, 4%
8 Other, 8%



RCSA brings researchers together to encourage cross-disciplinary collaborations and to build new communities in science. The ultimate goal: to more efficiently address challenges of global significance.

It should be noted that Cottrell Scholars are deeply committed to the ideal of the teacher-scholar at our nation's research universities, and therefore their attitudes toward teaching may be more positive than some of their colleagues. Scholars also tend to be enthusiastic supporters of their departments and evidence great respect for their colleagues, which might explain the low percentage response to item 3. The fact is, at every annual Cottrell Scholar Conference held in recent years, we have heard the repeated, widespread complaint that devotion to teaching simply isn't valued as much as devotion to research.

Clearly, however, the emphasis in this poll question fell decidedly upon the need for more effective science curricula. In this regard, one example of the effectiveness of the catalytic CSA approach was made clear to RCSA in 2011, in a communication from Keivan G. Stassun, associate professor of astronomy at Vanderbilt University and an adjunct professor of physics at Fisk University. He writes:

"The Cottrell Scholar Award I received was instrumental in launching the Fisk-Vanderbilt Masters-to-PhD Bridge Program. The program is a model for significantly broadening the participation of women and underrepresented minorities attaining the Ph.D. in the physical sciences through research-based partnerships linking Vanderbilt with neighboring historically African-American colleges and universities.

The key innovation of the program is its leveraging of the Master's degree as a critical juncture in the Ph.D. pipeline for underrepresented minorities; statistics show that minorities are 50% more likely than their non-minority peers to earn a terminal Master's degree as a stepping stone to the Ph.D.

By completing a Master's degree at Fisk University under the guidance of caring faculty mentors at Fisk and Vanderbilt, students develop the strong academic foundation, research skills, and one-on-one mentoring relationships that will foster a successful transition to the Ph.D. at Vanderbilt.

Since its inception, the program has admitted 51 students, 45 of them underrepresented minorities (all U.S. citizens), 55% female, with a retention rate of 92%. This year the program becomes the top at a research university to award the Ph.D. to underrepresented minorities in astronomy, physics, and materials science, awarding more than 10 times the number of underrepresented minority Ph.D.s in these disciplines than peer institutions.

Already, since 2006, no institution awards more Master's degrees to African Americans in physics than Fisk, and Fisk has become one of the top 10 producers of Master's degrees in physics among all U.S. citizens. In addition, Fisk-Vanderbilt Bridge students have earned the nation's top graduate fellowships (e.g., NSF Graduate Research Fellowship, NASA Graduate Research Fellowship, etc.), and some of our graduates have transferred to other highly ranked programs, including Yale, University of Michigan, University of Chicago, and others.

So far the Bridge Program has established formal tracks in astronomy, chemistry, physics, materials science, and biology. The program is now being emulated at Columbia University, the University of Michigan, and by the American Physical Society's newly launched Minority Bridge Program initiative. MIT and Harvard are jointly launching a Postdoctoral Bridge Program modeled on the Fisk-Vanderbilt program's design and principles. The program has now received more than $30 million in support from federal funding agencies and from institutional investments from Vanderbilt and Fisk."

2011 Cottrell Scholar Conference

At the 2011 Cottrell Scholar Conference, co-chaired by Jairo Sinova (Physics, Texas A&M) and Silvia Ronco (RCSA), the following three keynote conference lecturers addressed important challenges in undergraduate education:

Judith A. Ramaley
Former Assistant Dirctor of the NSF Education and Human Resource (EHR) Directorate and current President of Winona State University

Ramaley talked about attraction and retention of undergraduates in science careers.

Mary Ann Rankin
Dean of Natural Sciences at the University of Texas, Austin

Rankin discussed local programs that have been implemented at the national level.

Joan Ferrini-Mundy
Current Assistant Director for NSF-EHR

Ferrini-Mundy discussed federal funding opportunities and provided an overview of science policy issues.

Each lecture was followed by a dialog session facilitated by:

Elizabeth F. McCormack
Dean of Graduate Studies and Physics Professor at Bryn Mawr College

The conference program included breakout sessions to facilitate dialog among participants and set the stage for team formation and collaborative work.

Topics of breakout sessions included:

Institutional Framework
Promotion and Tenure Policies
Undergraduate Research Models
Undergraduate Curriculum
Cottrell Scholar Collaborative

As a symbol of the 2011 conference theme of collaboration, all attending Cottrell Scholars were presented with trophies made by the Tucson-based glass artist Paul Anders-Stout. The trophy ceremony set the tone for the intensive collaborative work during the conference.

At the 2011 Cottrell Scholar Conference, Cottrell Scholars presented their educational activities and discussed their dream outcomes:

Lane Allen Baker, CSA 2009
Chemistry, Indiana University

Motivations—Dream Outcomes

Sarbajit Banerjee, CSA 2010
Chemistry, University at Buffalo

Looking Outward from the Central Science: An Interdisciplinary "Research Skills" Laboratory Course

Duncan A. Brown, CSA 2010
Physics, Syracuse University

Improving the Undergraduate Science Experience for Non-Science Majors

Richard L. Brutchey, CSA 2010
Chemistry, University of Southern California

Solar Energy Research Internships: A Partnership with a Local Community College in Los Angeles County

Mark Anthony Caprio, CSA 2010
Physics, University of Notre Dame

Computational Problem Solving in the Undergraduate Physics Major

Linda Columbus, CSA 2010
Chemistry, University of Virginia

Goodbye Lectures; Hello Learning

Christopher J. Douglas, CSA 2010
Chemistry, University of Minnesota

A Hybrid Guided Inquiry/Traditional Lecture Approach to Organic Chemistry Instruction in Large Classrooms

Joshua S. Figueroa, CSA 2010
Chemistry, University of California, San Diego

UCCRO: Undergraduate Computational Chemistry Research Opportunity

Maura Ann McLaughlin, CSA 2009
Astronomy, West Virginia University

Pulsar Searching and the Three "R"s of Undergraduate Physics Education

Jennifer Ross, CSA 2010
Physics, University of Massachusetts, Amherst

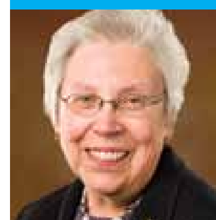
Optics for Biophysics: An Interdisciplinary Advanced Laboratory Course in Optics

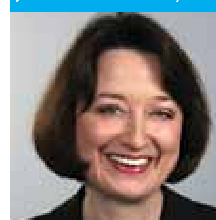
Snezana Lynn Stanimirovic, CSA 2009
Astronomy, University of Wisconsin, Madison

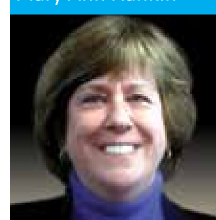
The Astronomical Observation Laboratory and More


Sarbajit Banerjee

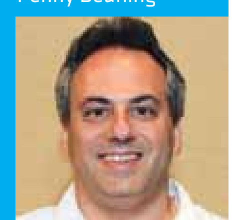

Linda Columbus

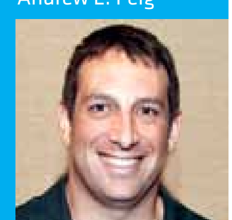

Judith A. Ramaley


Mary Ann Rankin


Joan Ferrini-Mundy


Penny Beuning


Andrew L. Feig


Adam Leibovich

Cottrell Scholar Collaborative Awards

In 2011, RCSA did not make any individual Cottrell Scholar awards. Three grants—named Cottrell Scholar Collaborative Awards—were made during the 2011 CSA Conference in Tucson. The awards encourage the Scholars to work together to improve teaching at research universities. They include:

Effective Practices in Learning and Pedagogy from Cottrell Scholars: A High-Impact Text for Education Leadership in the 21st Century

Penny Beuning
Assistant Professor of Chemistry
Northeastern University

Scott A. Snyder
Associate Professor of Chemistry
Columbia University

David Z. Besson
Professor of Physics, University of Kansas

Although there are several resources on effective teaching practices, there is currently no single, practical, and personal resource that offers advice for new faculty at research institutions on how to best develop their courses, utilize new pedagogy, develop effective outreach, and mentor students. This project's goals are to survey the combined experiences and collective wisdom of 240 Cottrell Scholars to develop a book and website to provide advice and experiences on these issues. The grantees will assemble materials that will provide both positive and negative experiences, examples of educational research that was particularly influential, highlights of educational misconceptions that were valuable to have overcome, and resources that have proven particularly helpful, all with a focus on lessons learned. They have developed a comprehensive survey, evaluated by several consultants, to gather information on personal experiences with teaching and mentoring. The entire community of Cottrell Scholars will be invited to complete the survey in early 2012.

New Faculty Orientation to Support the Development of Research Scholars

Rory Waterman
Assistant Professor of Chemistry
University of Vermont

Andrew L. Feig
Associate Professor of Biochemistry
Wayne State University

Additional Participants

Darren W. Johnson
Associate Professor of Chemistry
University of Oregon

William S. Jenks
Assistant Professor of Chemistry
Iowa State University

Lane Allen Baker
Assistant Professor of Chemistry
Indiana University

Jennifer Ross
Assistant Professor of Physics
University of Massachusetts at Amherst

Linda Columbus
Assistant Professor of Chemistry
University of Virginia

There is no manual on how to be an assistant professor. The Cottrell Scholar New Faculty Orientation will address a key issue in the early-career for incoming faculty in chemistry, physics and astronomy: that teaching is an essential part of the assistant professor's career, and that effective teaching need be neither onerous nor deleterious to research. In fact, research-proven best practices exist that make teaching more effective for students while benefitting the research program itself. The participants in the New Faculty Orientation will be introduced to best teaching practices and a resource of effective teaching practices as well as like-minded research scholars.

Cottrell Scholars Collaborative Think-and-Do Tank

Jennifer Ross
Assistant Professor of Physics
University of Massachusetts at Amherst

James D. Martin
Professor of Chemistry
North Carolina State University

Additional Participants

Adam Leibovich
Associate Professor of Physics
University of Pittsburgh

Karen S. Bjorkman
Professor of Astronomy
University of Toledo

Karl T. Mueller
Professor of Chemistry
Penn State University

Tehshik R. Yoon
Professor of Chemistry
University of Wisconsin-Madison

Catherine J. Murphy
Professor of Chemistry
University of Illinois, Urbana-Champaign

Michael L. Hayden
Professor of Physics
University of Maryland-Baltimore

Michael D. Hildreth
Associate Professor of Physics
University of Notre Dame

Rory Waterman
Assistant Professor of Chemistry
University of Vermont

The objective of this project is to form a "think-and-do tank" that will infuse the ideas and mission of the Cottrell Scholars collaborative (CSC) into public consciousness. The mission of the CSC is to develop, promote and implement transformative initiatives for the integration of research and teaching of science undergraduates at research universities. Goals include:

1. Make real, significant improvements to the education of university and college students.
2. Inform public opinion regarding the essential synergy between university research and education.
3. Shape opinion of decision makers at three levels: peers at the individual level, institutional leaders, and national agencies.
4. Create a public face for the CSC.

Cottrell College Science Awards

The Cottrell College Science Award (CCSA) program, RCSA's oldest initiative, was created in the early 1970s to promote basic research as a vital component of undergraduate education at primarily undergraduate institutions (PUIs). Over the decades the CCSA program has consistently:

- →Strengthened teacher-scholars while supporting high-quality research at PUIs;
- →Helped early-career faculty become competitive for federal funding;
- →Encouraged faculty to conduct meaningful collaborative work with undergraduate researchers, and;
- →Enhanced the research culture of numerous science departments at public and private institutions in the United States.

In the last 15 years the CCSA program has supported the research work of approximately 1,300 PUI faculty in over 400 institutions, and has generated research opportunities for thousands of undergraduates at both public and private institutions. These awards, meant to provide seed money to jump-start productive research programs, have proven to be a great tool to engage students in independent research, thus inspiring in them a passion for discovery and self-inquiry. One of our important goals is to motivate students to pursue careers in research and to become the advanced scientific workforce America will need to remain prosperous and safe in the challenging decades to come.

In response to increasingly complex scientific challenges that call for interdisciplinary topics and approaches, RCSA has recently modified the CCSA program to better serve academic researchers. Under today's guidelines, our Single-Investigator Awards provide research support for early-career faculty with interests in the fields of chemistry, physics and astronomy and in closely related fields that overlap significantly with these three disciplines.

In addition, we've begun a new initiative, the Multi-Investigator Awards, to encourage early-career faculty to establish in-house, interdisciplinary research collaborations. We hope that faculty and administrators will embrace the interdisciplinary model emphasized in the Multi-Investigator Program, and that our programs will continue to assist faculty to conduct frontier research with undergraduates.

2011 Cottrell College Science Awards Multi-Investigator Awardees

Steven. W. Suljak
Santa Clara University
Chemistry

and

John T. Birmingham
Santa Clara University
Physics

Jennifer M. Steele
Trinity University
Physics

and

Bert Chandler
Trinity University
Chemistry

2011 Cottrell College Science Awards Single-Investigator Awardees

Kurt Andresen
Gettysburg College
Physics

Lauren Benz
University of San Diego
Chemistry

Michelle R. Bunagan
College of New Jersey
Chemistry

Dale Cameron
Ursinus College
Biology

Lionel E. Cheruzel
San Jose State University
Chemistry

Emma J. Coddington
Willamette University
Biology

Anca Constantin
James Madison University
Astronomy

Bhaskar Datta
Missouri State University
Chemistry

Trinanjan Datta
Augusta State University
Physics

Karl J. Feierabend
College of Wooster
Chemistry

Jennifer Furchak
Kalamazoo College
Chemistry

John T. Giblin
Kenyon College
Physics

Gergely Gidofalvi
Gonzaga University
Chemistry

David P. Gillikin
Union College
Geology

Serguei Goupalov
Jackson State University
Physics

Nicholas E. Grossoehme
Winthrop University
Chemistry

Todd W. Hudnall
Texas State University, San Marcos
Chemistry

Woo-Joong "Andy" Kim
Seattle University
Physics

Derrick R.J. Kolling
Marshall University
Chemistry

Tracy L. Kress
College of New Jersey
Biology

Christopher Laperle
Providence College
Chemistry

Robert B. Lettan
Chatham College
Chemistry

Laura Listenberger
Saint Olaf College
Chemistry

Yong Liu
University of Colorado, Denver
Chemistry

Justin C. Lytle
Pacific Lutheran University
Chemistry

Emily C. McLaughlin
Bard College
Chemistry

Kenneth A. Miller
Fort Lewis College
Chemistry

Kevin M. Miller
Murray State University
Chemistry

Christine Morales
University of Wisconsin, Eau Claire
Chemistry

Hector Palencia
University of Nebraska, Kearney
Chemistry

Margot G. Paulick
Union College
Chemistry

Pushpa Raghani
Boise State University
Physics

Alexander Samokhvalov
Rutgers University, Camden
Chemistry

Tanya Schneider
Connecticut College
Chemistry

Joshua Schrier
Haverford College
Chemistry

Kelly Sheppard
Skidmore College
Chemistry

Kari L. Stone
Benedictine University
Chemistry

Riina Tehver
Denison University
Physics

Leeann E. Thornton
College of New Jersey
Biology

Alan E. van Giessen
Hobart and William Smith Colleges
Chemistry

David Vuletich
SUNY College at Brockport
Chemistry

James D. West
College of Wooster
Chemistry

Korin E. Wheeler
Santa Clara University
Chemistry

Matthew T. Whited
Carleton College
Chemistry

Steven T. Whitten
Texas State University, San Marcos
Chemistry

Peter J. Woodruff
University of Southern Maine
Chemistry

Arizona Partners in Science Awards

Arizona Partners in Science, an RCSA program in conjunction with the M.J. Murdock Charitable Trust, provides summer research opportunities for high-school science teachers under the supervision of faculty members at Arizona universities.

The objective of this program is to provide Arizona high-school science teachers the opportunity to work on summer research projects in collaboration with individual science faculty at universities within the state. The main goals of this program are to help improve grade 9-12 science education and increase the number of students who choose to pursue science careers.

Bradley Davidson
University of Arizona
Steven Uyeda
Sunnyside High School
Tucson
Analysis of Heart Gene Regulation

Stefano Guerra
University of Arizona
Justin Ray Sherrill
Desert Ridge High School
Mesa
Serum Biomarkers of Mortality Risk: A 40-year Follow-up Study

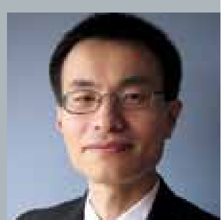
Stephen G. Kukolich
University of Arizona
Maria Grace Javier
Salpointe Catholic High School
Tucson
Microwave Spectroscopy Measurements of Spectra and 3-D Structures of Hydrogen-Bonded Complexes

Gary L. Christopherson
University of Arizona
Laura Schoenle
Salpointe Catholic High School
Tucson
Wildfire and Bird Habitat: Discovering the Relationship Between the Fire Return Interval and the Abundance of Open Woodland Bird Species

Maria Grace Javier

Recognition of RCSA Grantees


Scott Snyder


Peidong Yang

Columbia University Chemistry Professor **Scott Snyder**, named a Cottrell Scholar in 2009, was lead author of a paper, published in June in *Nature*, on a novel methodology for potentially scalable synthesis of the resveratrol family of polyphenols.

Gregory J. Grant, Irvine W. Grote Professor of Chemistry at the University of Tennessee at Chattanooga, has won the American Chemical Society's award recognizing the importance of research with undergraduates. Established in 1986 by RCSA, the award honors a chemistry faculty member whose research in an undergraduate setting has achieved wide recognition and contributed significantly to chemistry and to the professional development of undergraduate students.

Janet Seger, professor and chair of the Department of Physics in the College of Arts and Sciences at Creighton University, has received the 2011 American Physical Society Award for Faculty Working with Undergraduate Researchers. The award was established by RCSA in 1986. It is given to a physicist "whose research in an undergraduate setting has achieved wide recognition and contributed significantly to physics and who has contributed substantially to the professional development of undergraduate physics students."

Peidong Yang, Professor of Chemistry, University of California at Berkeley, has won the 2011 Leo Hendrik Baekeland Award. Yang won a RCSA Research Innovation Award in 2000, and he will be a keynote speaker at the 3rd Annual Scialog Conference in October 2012. The Baekeland Award, established in September 1944 by the North Jersey Section of the American Chemical Society, has been sponsored by the Union Carbide Corporation, a subsidiary of The Dow Chemical Company. The gold-plated medal and $5,000 award is conferred biennially upon an American chemist under 40 years of age in recognition of accomplishments in pure or industrial chemistry, as characterized by the initiative, creativeness, leadership, and perseverance of the individual and indicated by published or unpublished evidence. The award was established to commemorate the technical and industrial achievements of Baekeland and to encourage younger chemists to emulate his example.

2011 Financial Summary

The financial activities of Research Corporation for Science Advancement were audited by Keegan, Linscott & Kenon, PC. For the complete audited financial statement, please visit our website at rescorp.org.

Where Our Money Goes

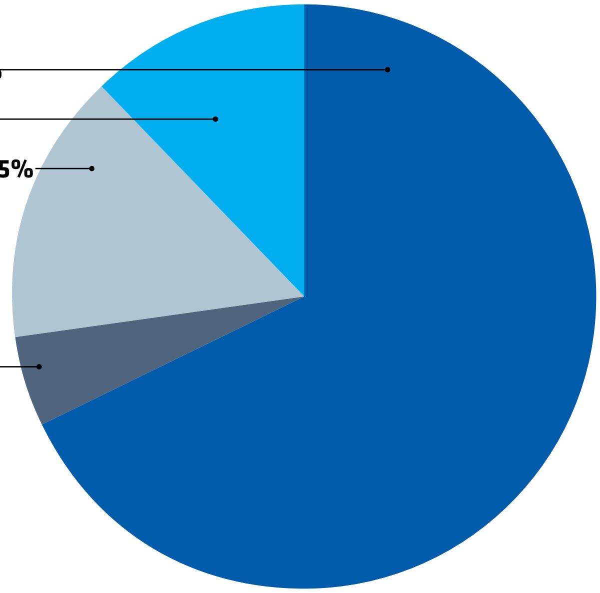
Total Expenses $7,967,161

Grants, Awards & Programs **68%**

Centennial Programs **12%**

General & Administrative Costs **15%**

Partnership Development & Fundraising **5%**



Grants and Awards Approved $3,430,496*

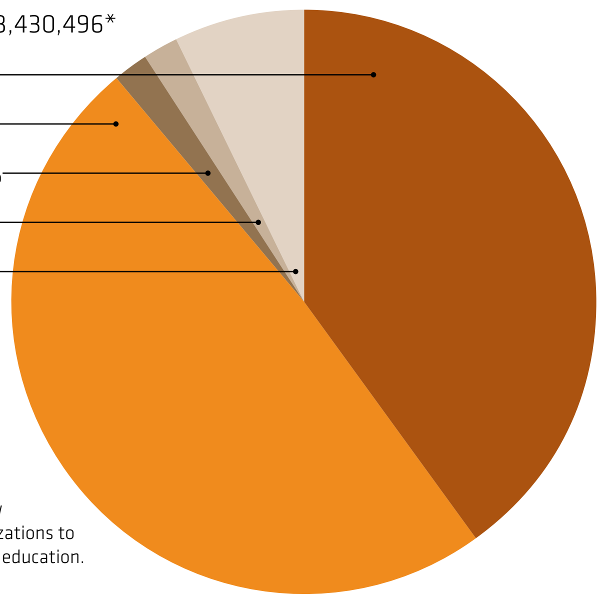
Scialog **40%**

Cottrell College Science **49%**

Cottrell Scholar Collaborative **2%**

Arizona Partners in Science **2%**

Science in the Public Interest, Discretionary Grants & Special Initiatives **7%**



*Items in this category reflect funds that flow directly to institutions, scientists and organizations to advance their efforts in research and science education.

Net Assets at Beginning of Year $131,343,156

Net Assets at End of Year $121,789,242

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Research Corporation Board Chair, President & CEO, Energy Global, Inc.

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James M. Gentile
President and CEO of Research Corporation for Science Advancement. Former Dean for Natural Sciences and endowed professor in biology at Hope College in Holland, Michigan. Ex officio member on all committees.

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