Surpassing Evolution: Transformative Approaches to Enhance the Efficiency of Photosynthesis

A joint Ideas Lab activity between NSF and BBSRC

PROGRAM SOLICITATION

NSF 10-559

National Science Foundation

Directorate for Biological Sciences
Division of Molecular and Cellular Biosciences
Division of Integrative Organismal Systems
Emerging Frontiers

Preliminary Proposal Due Date(s) *(optional):*

June 15, 2010

For participation in the Ideas Lab workshop to be held September 13-17, 2010 at the Asilomar Conference Center, CA. Selected participants will be notified by July 16, 2010. Required for consideration of participation in the Ideas Lab.

Full Proposal Deadline(s) (due by 5 p.m. proposer's local time):

November 01, 2010

All full proposals, whether or not developed through the Ideas Lab, must be received by the deadline. Proposers do not need to have participated in the Ideas Lab to submit a full proposal.

IMPORTANT INFORMATION AND REVISION NOTES

Please be advised that the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) includes revised guidelines to implement the mentoring provisions of the America COMPETES Act (ACA) (Pub. L. No. 110-69, Aug. 9, 2007.) As specified in the ACA, each proposal that requests funding to support postdoctoral researchers must include a description of the mentoring activities that will be provided for such individuals. Proposals that do not comply with this requirement will be returned without review (see the PAPP Guide Part I: *Grant Proposal Guide* Chapter II for further information about the implementation of this new requirement).

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Surpassing Evolution: Transformative Approaches to Enhance the Efficiency of Photosynthesis
A joint Ideas Lab activity between NSF and BBSRC

Synopsis of Program:

Photosynthesis is the basis of energy capture from the sun in plants and algae and has the potential to be harnessed for major increases in biomass yield - whether that is for bioenergy, production of renewable chemicals or boosting crop yields for food. Increasing the efficiency of photosynthesis is likely to provide solutions for the food, energy, and environmental challenges of the future. While numerous efforts to increase photosynthetic efficiency have been made, few gains have been realized. Nevertheless, an increasingly detailed picture of photosynthetic mechanisms has been obtained. The emergence of new integrative bioscience including areas such as functional genomics, metabolic flux analysis, and synthetic biology bring novel strategies that can position scientists to surpass those limits. This solicitation encourages proposals that have the potential to enhance the efficiency and sustainability of photosynthesis beyond current limits.

The key objective of this joint activity between the National Science Foundation (NSF) in the US and the Biotechnology and Biological Sciences Research Council (BBSRC) in the UK is to stimulate innovative and transformative research proposals for the enhancement of photosynthetic efficiency. The proposals funded through this activity will include ideas that could lead to a sea-change in our knowledge, rather than incremental advances. The proposals will be generated in an Ideas Lab by multidisciplinary teams, which in addition to scientists from a traditional biology background may include researchers with expertise in physics, engineering, mathematical modeling, computer science, chemistry or any other discipline which may help to shed light on the topic. Members of the photosynthesis research community and specialists in other areas including but not limited to bioenergetics,

metabolic engineering, synthetic biology, modeling, and systems biology are strongly encouraged to participate.

The aspiration is that mixing researchers from diverse backgrounds will engender fresh thinking and approaches that can be brought to bear on the long-standing problem of increasing efficiency of photosynthesis. In addition, by bringing together the best researchers from the US and the UK, the intention is to form strong transatlantic alliances, where the resulting synergies from the expertise of each partner, allows for significant added value.

US and UK researchers can submit preliminary proposals via FastLane for participating in the Ideas Lab in which a set of multidisciplinary ideas will be developed. These will be submitted as full proposals. Alternatively, US researchers who cannot or do not desire to participate in the Ideas Lab can submit full proposals directly in response to this solicitation. Collaboration among researchers from USA and UK is strongly encouraged in the full proposals. International research collaborations between the researchers from USA and from UK are strongly encouraged in the full proposals.

Cognizant Program Officer(s):

- Mark Brodl, telephone: (703) 292-7879, email: photosynthesis@nsf.gov.
- Robert Burnap, telephone: (703) 292-7582, email: photosynthesis@nsf.gov.

Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.074 --- Biological Sciences

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 5 to 10 Up to 10 awards will be made in FY2011, pending availability of funds and the type, scale, and variety of project ideas developed at the Ideas Lab or submitted directly to NSF.

Anticipated Funding Amount: $6,000,000 Up to $4,000,000 will be available for US researchers in FY2011 for successful proposals through the Ideas Lab, pending availability of funds and compelling proposals. Equivalent funds will be available from BBSRC for UK researchers. Up to $2,000,000 in additional funds will be available in FY2011 for proposals in this competition not developed through the Ideas Lab.

Eligibility Information

Organization Limit:

None Specified

PI Limit:

None Specified

Limit on Number of Proposals per Organization:

None Specified

Limit on Number of Proposals per PI: 1

The limit on number of proposals per PI applies to the preliminary proposal stage only.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not Applicable
- **Preliminary Proposals:** Submission of Preliminary Proposals is optional. Please see the full text of this solicitation for further information.
- **Full Proposals:**
  - Full Proposals submitted via FastLane: NSF Proposal and Award Policies and Procedures Guide, Part I: Grant Proposal Guide (GPG) Guidelines apply. The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg.
  - Full Proposals submitted via Grants.gov: NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov Guidelines apply (Note: The NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide)

B. Budgetary Information

- **Cost Sharing Requirements:** Cost Sharing is not required under this solicitation.
- **Indirect Cost (F&A) Limitations:** Not Applicable
- **Other Budgetary Limitations:** Not Applicable

C. Due Dates

- **Preliminary Proposal Due Date(s)** ***(optional):***

  June 15, 2010

  For participation in the Ideas Lab workshop to be held September 13-17, 2010 at the Asilomar Conference Center, CA. Selected participants will be notified by July 16, 2010. Required for consideration of participation in the Ideas Lab.

- **Full Proposal Deadline(s)** (due by 5 p.m. proposer's local time):

  November 01, 2010

  All full proposals, whether or not developed through the Ideas Lab, must be received by the deadline. Proposers do not need to have participated in the Ideas Lab to submit a full proposal.

Proposal Review Information Criteria

Merit Review Criteria: National Science Board approved criteria. Additional merit review considerations apply. Please see the full text of this solicitation for further information.

Award Administration Information

Award Conditions: Standard NSF award conditions apply.

Reporting Requirements: Standard NSF reporting requirements apply.

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I. INTRODUCTION

Photosynthesis is the process by which solar energy is converted into useful chemical energy. In natural photosynthesis, light energy is harnessed to fix carbon in plants, algae and bacteria and oxygen is released as a byproduct. Thus, photosynthesis is responsible for the primary productivity of the biosphere and has made this planet hospitable for the heterotrophic forms of life. It is the mechanism that allows plants to grow and to produce food and chemical feedstocks that can serve as an alternative to petrochemicals. Basic research into photosynthesis has confirmed that substantial improvements are theoretically possible given the fundamental inefficiency of photosynthesis in many major crops (most cereals, legumes and vegetables) where the photosynthetic efficiency is up to 6%. The efficiency varies according to many factors, including the wavelength of the light being captured, light intensity, temperature and the concentration of CO_2 in the atmosphere. Improving the efficiency of natural photosynthesis offers the prospect of novel technologies to enhance plant and algal yields for food production and biomass as a source of biofuels and chemicals. Besides natural photosynthesis, engineered forms of photosynthesis have been envisioned to by-pass the often-limiting natural carbon fixation reactions and to re-direct photosynthetic reductant to other products such as hydrogen or simple hydrocarbons. The current state of our knowledge leaves many questions unanswered and proposals in this activity will address these questions through novel multidisciplinary approaches. Some examples of such unanswered questions include:

- How can we enhance the efficiency and sustainability of photosynthesis beyond current biological limits that are the result of Darwinian evolution?
- How can we best leverage the current detailed state of photosynthetic knowledge into new systems-oriented approaches to understanding and manipulating photosynthetic processes in organisms?
- What basic research areas and strategies need to be developed to harness photosynthetic organisms to meet increasing demands for food given the present demographic and climate trends?

Increasing photosynthetic efficiency will help in securing a sustainable food supply for a growing population. Current estimates indicate that food supplies need to increase by 50% before 2030 and by 100% before 2050. There is, thus, an urgent need to identify and exploit novel scientific approaches to increase the productivity of the major crops to secure sustainable global food supplies. A number of factors are leading to an increased pressure on current food production. These include: the continued growth in the world population resulting in increased demands for food (by 2050, the world population is projected to grow to over 9 billion), the increase in affluence and urbanization, the decrease in existing land productivity through the impacts of climate change, the shortage of fresh water and increased cost of fertilizers, the competition for land between agriculture and other uses, including the need for alternative sustainable fuels such as biofuels. In brief, to provide sustainable food supplies, it is necessary to produce more food from less land using fewer inputs such as water and fertilizers and, at the same time, reduce agricultural greenhouse gas emissions. Much can be done to increase crop yields by incremental improvements in agronomy and breeding, but if we are to meet the significant dual challenges of bioenergy and global food security in the years ahead, then a step-change in productivity is required. Enhancing photosynthetic efficiency offers such an approach.

II. PROGRAM DESCRIPTION

There are fundamental bioenergetic and metabolic limitations in increasing the efficiency of photosynthesis. This solicitation is aimed at innovative ways of answering basic questions on these limitations, as well as considering new bioengineering possibilities that may be developed for photosynthetic systems. Could new approaches be developed that potentiate increases in the efficiency and sustainability of photosynthesis beyond current limits? How well can the efficiencies be predicted or manipulated and what are the controlling variables? This solicitation is not aimed at specific applied approaches (e.g. methods for increased biomass production from a particular species) to address these critical downstream needs. Instead, it is aimed at the identification of opportunities to advance state-of-the-art of photosynthesis research in ways that provide new conceptual foundations for both achieving a step-increase in photosynthetic efficiency and subsequent application. The photosynthesis research community and specialists in other areas including, but not limited to bioenergetics, metabolic engineering, synthetic biology, modeling, and systems biology, as well as those from diverse disciplines such as physics, engineering, mathematics, and modelers *inter alia* are strongly encouraged to apply. Please note that this solicitation invites research proposals through two mechanisms. First, individual researchers from any discipline can submit a preliminary proposal for participation in the Ideas Lab (see below), which will include researchers from UK as well as USA. Second, an individual or a group of researchers from the US can submit a regular research proposal addressing the goals of this solicitation at the full proposal deadline; collaborations with UK scientists are encouraged in these proposals as well.

An Ideas Lab for Innovation

The goal of this BBSRC-NSF Ideas Lab is to develop new approaches to advance the goal of increasing photosynthetic yield, through approaches that leverage new and emerging research and technology. To address this goal, BBSRC and NSF will hold an interactive workshop (Ideas Lab) to be held at Asilomar Conference Center in California (USA) from **13 to 17 September 2010**.

Given the current state of knowledge in this area, transformative progress demands an innovative and multidisciplinary approach. Consequently, the Ideas Lab will bring together researchers from across all disciplines to explore new and exciting avenues of research in this area and to stimulate thinking in promising new or currently under-developed areas of photosynthesis. The BBSRC and the NSF plan to allocate up to $4M each, subject to availability of funds and compelling proposals to support genuinely novel and potentially transformative research arising from the Ideas Lab.

Participants will be expected to engage constructively in dialogue with each other, the facilitators, and the Director and Mentors to develop collaborative research proposals. Collaboration will be encouraged, especially in bringing great minds together from both sides of the Atlantic to embrace this challenge.

Ideas Labs feature an intensive interactive workshop involving up to 30 participants brought together with the aim of developing new and bold approaches to address grand challenges in areas that could benefit from a new dimension in thinking. The activity is led by a group of international experts (known as Mentors). These individuals forfeit access to funds allocated to the projects that emerge from the Ideas Lab and therefore act as impartial referees in the process. One of the Mentors serves as the Director of the Ideas Lab and coordinates the discussions and decisions by the Mentors. While the Mentors focus on scientific content, Ideas Lab Facilitators are professionals who focus on the Ideas Lab process. They design sessions and activities to create conditions for the formation, refinement and advancement of innovative ideas. The Ideas Lab Participants are selected to ensure that they from a range of disciplines and backgrounds to foster multidisciplinary approaches, and have a mix of personal attributes that may increase the transformative nature of the outcomes, such as a willingness to take risks, good communication skills, and creativity.

The Ideas Lab requires participants to leave preconceptions behind. The process can be broken down into several stages:

- Defining the scope of the challenges
- Evolving common languages and terminologies amongst people from a diverse range of backgrounds and disciplines
- Sharing understandings of the challenges, and the expertise brought by the participants to the Ideas Lab
- Taking part in break-out sessions focused on the challenges, using creative thinking techniques
- Capturing the outputs in the form of highly innovative research projects
- Using "real-time" peer review to develop projects at the Ideas Lab

This process is iterative, with several rounds of development and refinement. Facilitators monitor the process as it unfolds, adapting schedules and activities to keep the group focused and moving forward. The Ideas Lab will be an intensive event. For the well-being of participants, the venue offers opportunities for relaxation, and the timetable will include networking and other activities as a break from the detailed technical discussions.

Outcomes of the Ideas Lab are outlines of research projects that vary in scale and scope and that complement each other in addressing the grand challenge topic of the Ideas Lab. A special feature of the Ideas Lab process is that funding is set aside at the outset (pending the availability of funds) to support some or all of the research projects that emerge from the Ideas Lab process, depending on research quality and novelty. The aim of this BBSRC-NSF Ideas Lab is to provide a meeting point for a wide range of scientists from a variety of disciplines to consider photosynthesis in its broadest sense and propose innovative, exciting, and tractable approaches for realizing increased photosynthetic yield. Anyone eligible to apply for funding from the NSF or BBSRC is eligible to submit an application to participate in the Ideas Lab.

Applications for this activity

In brief, individuals interested in participating in the Ideas Lab should respond to this solicitation by submitting applications to participate in the workshop as preliminary proposals. Submission of the preliminary proposal will be considered an indication of availability to attend and participate through the full course of the five-day residential workshop, which will be held at Asilomar on **September 13-17, 2010**. Participants will be selected on the basis of the interests, expertise, and other characteristics described in their submitted preliminary proposals. All participants should be willing to engage in frank disclosure and assessment of ideas in a collegial and professional fashion. The Director and Mentors will recommend a list of potential participants and NSF and BBSRC Program Staff will select the final list of participants from the submitted preliminary proposals.

Following the Ideas Lab, participants will submit full proposals to NSF and BBSRC by the November 1, 2010 deadline; these full proposals will reflect the outline developed at the workshop.

US proposers who did not participate in the Ideas Lab (whether or not a preliminary proposal was submitted) can submit full proposals to NSF by the November 1, 2010 deadline for consideration in this program. These proposers are also encouraged to collaborate with UK researchers in their projects, if appropriate for the scope of the project. Participation in the Ideas Lab is not required for submission of a proposal to this program. Further details of the proposal preparation and submission process are described in Section IV of this document.

III. AWARD INFORMATION

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

IV. ELIGIBILITY INFORMATION

Organization Limit:

None Specified

PI Limit:

None Specified

Limit on Number of Proposals per Organization:

None Specified

Limit on Number of Proposals per PI: 1

The limit on number of proposals per PI applies to the preliminary proposal stage only.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Preliminary Proposals*(optional):*

Submission of Preliminary Proposals is required for participation in the Ideas Lab. Please note, the Preliminary Proposal must come from one individual and cannot include coPIs or collaborators. Participants in the Idea Lab will be selected on the basis of information submitted in the preliminary proposal. The applications are limited to **two pages of "Project Description**," that should be submitted as a preliminary proposal in the NSF FastLane system **ONLY**, not through Grants.gov. Standard NSF formatting guidelines will apply. See the NSF Grant Proposal Guide (GPG) for guidance.

The Project Description section of the preliminary proposal applications should conform to the following guidelines:

Page one:

- Provide a brief summary of your professional background (no more than one half page).
- What expertise do you bring that is relevant to realizing the full potential of photosynthesis? (no more than one-half page).

Page two:

Please spend some time considering your answers to the following questions. Your responses (no more than 150 words each) should demonstrate that you have suitable skills and aptitude to participate in the Ideas Lab (unrelated to your research track record).

- What is your personal experience with working in teams?
- How would you describe your ability to explain your research to non-experts?

The Ideas Lab environment is especially suited to individuals who are willing to step outside their particular area of interest or expertise, who are positively driven, who enjoy creative activity, who can think innovatively and who

can settle in easily in the company of strangers. Please describe an experience you have had in a comparable environment.

- What would you personally and professionally gain from participating in this Ideas Lab?

Applicants must include a Biographical Sketch and a Current and Pending Support document (prepared in accordance with standard NSF formatting guidelines). All other elements of a "full proposal" are waived (Project Summary, References Cited, Budget, Budget Justification, Facilities, Equipment and Other Resources).

No appendices or supplementary documents may be submitted.

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via Grants.gov or via the NSF FastLane system.

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the NSF Grant Proposal Guide (GPG). The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg. Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov. The complete text of the NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: (http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

In determining which method to utilize in the electronic preparation and submission of the proposal, please note the following:

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via the NSF FastLane system. Chapter II, Section D.4 of the Grant Proposal Guide provides additional information on collaborative proposals.

The full proposals should include a single copy document that contains a list of all persons with conflicts of interest with the investigators involved in the project. In case of the proposals with international collaboration, the UK collaborators should be added as senior personnel and their biographical sketches must be included. In addition, the budget of the UK component of the project requested from BBSRC should be included as a supplementary document. The budget should include funds for attendance at a PI meeting that will be held in UK in the second year of the project.

B. Budgetary Information

Cost Sharing: Cost sharing is not required under this solicitation.

C. Due Dates

- **Preliminary Proposal Due Date(s)** ***(optional):***

  June 15, 2010

  For participation in the Ideas Lab workshop to be held September 13-17, 2010 at the Asilomar Conference Center, CA. Selected participants will be notified by July 16, 2010. Required for consideration of participation in the Ideas Lab.

- **Full Proposal Deadline(s)** (due by 5 p.m. proposer's local time):

  November 01, 2010

  All full proposals, whether or not developed through the Ideas Lab, must be received by the deadline. Proposers do not need to have participated in the Ideas Lab to submit a full proposal.

There are two paths towards final submission of proposals to this activity - through the Ideas Lab or through direct submission of a full proposal. Applicants who do not wish to participate in the Ideas Lab should submit full proposals by the November 1 deadline. Participation in the Ideas Lab is not required to submit a full proposal.

D. FastLane / Grants.gov Requirements

- **For Proposals Submitted Via FastLane:**

  Detailed technical instructions regarding the technical aspects of preparation and submission via FastLane are available at: https://www.fastlane.nsf.gov/a1/newstan.htm. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov. The FastLane Help Desk answers general technical questions related to the use of the FastLane system. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

Submission of Electronically Signed Cover Sheets. The Authorized Organizational Representative (AOR) must electronically sign the proposal Cover Sheet to submit the required proposal certifications (see Chapter II, Section C of the Grant Proposal Guide for a listing of the certifications). The AOR must provide the required electronic certifications within five working days following the electronic submission of the proposal. Further instructions regarding this process are available on the FastLane Website at: https://www.fastlane.nsf.gov/fastlane.jsp.

- **For Proposals Submitted Via Grants.gov:**

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. The Grants.gov's Grant Community User Guide is a comprehensive reference document that provides technical information about Grants.gov. Proposers can download the User Guide as a Microsoft Word document or as a PDF document. The Grants.gov User Guide is available at: http://www.grants.gov/CustomerSupport. In addition, the NSF Grants.gov Application Guide provides additional technical guidance regarding preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

Submitting the Proposal: Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to the NSF FastLane system for further processing.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program where they will be reviewed if they meet NSF proposal preparation requirements. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with the oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal.

A. NSF Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board (NSB)-approved merit review criteria: intellectual merit and the broader impacts of the proposed effort. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two NSB-approved merit review criteria are listed below. The criteria include considerations that help define them. These considerations are suggestions and not all will apply to any given proposal. While proposers must address both merit review criteria, reviewers will be asked to address only those considerations that are relevant to the proposal being considered and for which the reviewer is qualified to make judgements.

What is the intellectual merit of the proposed activity?
How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of the prior work.) To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

What are the broader impacts of the proposed activity?
How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

Examples illustrating activities likely to demonstrate broader impacts are available electronically on the NSF website at: http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf.

Mentoring activities provided to postdoctoral researchers supported on the project, as described in a one-page supplementary document, will be evaluated under the Broader Impacts criterion.

NSF staff also will give careful consideration to the following in making funding decisions:

Integration of Research and Education
One of the principal strategies in support of NSF's goals is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the diversity of learning perspectives.

Integrating Diversity into NSF Programs, Projects, and Activities
Broadening opportunities and enabling the participation of all citizens -- women and men, underrepresented minorities, and persons with disabilities -- is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

Additional Review Criteria:

This activity, particularly the Ideas Lab approach, is designed to support the development and implementation of creative and innovative project ideas that have the potential to transform research paradigms and/or solve intractable problems. We anticipate that awards made through this solicitation will be high-risk/high-impact, as they represent new and unproven ideas, approaches and/or technologies. Projects that involve the application of novel, collaborative, or interdisciplinary approaches will therefore receive priority during the consideration process. In addition, if the full proposals are derived from the Ideas Lab, the full proposals will be evaluated to determine if the scientific themes/objectives in the project are congruent with the ideas presented at the Ideas Lab, and if any significant changes in project scope or resources from those presented at the Ideas Lab have been justified.

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review, or Ideas Lab.

Proposals submitted in response to this program solicitation will be reviewed by Ideas Lab, ad hoc and panel review according to the following process:

Stage 1: A panel consisting of the Ideas Lab Director, Mentors and an occupational psychologist will review the preliminary proposals submitted by applicants and will advise NSF on participant selection. Final selection decisions regarding participation in the Ideas Lab will be made by the BBSRC and the NSF.

Overall, the Selection Panel will seek to ensure that a balance of expertise is present at the Ideas Lab; their assessment will be based on the specific criteria outlined below:

- The ability to develop new and highly original research ideas;
- The potential to contribute to research between disciplines;
- The ability to work in a team across academia and industry;
- The ability to explain research to non-experts.

Submission of the preliminary proposal will be considered an indication of commitment to attend and participate through the full course of the five-day residential Ideas Lab September 13-17, 2010, should the proposer be invited. The decisions of the funding agencies about whom to invite will be final and binding.

Stage 2: Applicants selected by the NSF and BBSRC Program Officers will participate in the Ideas Lab workshop, building collaborations and refining ideas. It is anticipated that proposals developed through the Ideas Lab would feature the following:

- Novel highly multidisciplinary research projects, clearly reflecting the distinctive opportunity for creating such projects that the Ideas Lab provides.
- Clear evidence that the team has the capability to deliver its project as a high quality multidisciplinary activity.
- Clear relevance to, and the potential to make a distinctive and novel contribution to, addressing the research challenge of enhancing photosynthesis.

Stage 3: Full proposals submitted directly to the program will be discussed by a panel. Proposals resulting from the Ideas Lab will be reviewed by the Mentors and funding recommendations will be made by NSF and BBSRC Program Officers. UK participants will submit proposals to BBSRC. Any collaborative project arising from the Ideas Lab and funded through this program must have a signed Collaboration Agreement between the partners that clarifies the contributions and rights of each partner before the start of any grant. The sponsors of the Program attach great importance to the dissemination of research findings and the publishing of information about the research they support in the public domain. However, all dissemination and publication must be carried out in the manner agreed in the project's Collaboration Agreement.

Stage 4: After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officers recommend to the cognizant Division Directors whether the proposal should be declined or recommended for award.

NSF is striving to be able to inform applicants whether their proposals have been declined or recommended for funding within six months. The time interval begins on the submission deadline for the full proposal and ends when the Division Director accepts the Program Officer's recommendation.

A summary rating and accompanying narrative will be completed and submitted by each reviewer. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

In all cases, after programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications and the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

Reviewers will be asked to formulate a recommendation to either support or decline each proposal. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF is striving to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director accepts the Program Officer's recommendation.

A summary rating and accompanying narrative will be completed and submitted by each reviewer. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

In all cases, after programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications and the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or

personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

B. Award Conditions

An NSF award consists of: (1) the award letter, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award letter; (4) the applicable award conditions, such as Grant General Conditions (GC-1); * or Research Terms and Conditions * and (5) any announcement or other NSF issuance that may be incorporated by reference in the award letter. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

*These documents may be accessed electronically on NSF's Website at http://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the NSF *Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer at least 90 days before the end of the current budget period. (Some programs or awards require more frequent project reports). Within 90 days after expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report will delay NSF review and processing of any future funding increments as well as any pending proposals for that PI. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through FastLane, for preparation and submission of annual and final project reports. Such reports provide information on activities and findings, project participants (individual and organizational) publications; and, other specific products and contributions. PIs will not be required to re-enter information previously provided, either with a proposal or in earlier updates using the electronic system. Submission of the report via FastLane constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

VIII. AGENCY CONTACTS

General inquiries regarding this program should be made to:

- Mark Brodl, telephone: (703) 292-7879, email: photosynthesis@nsf.gov.
- Robert Burnap, telephone: (703) 292-7582, email: photosynthesis@nsf.gov.

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: fastlane@nsf.gov.
- Alison Beason, telephone: (703) 292-8440, email: photosynthesis@nsf.gov.

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a confirmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: support@grants.gov.

IX. OTHER INFORMATION

The NSF Website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this Website by potential proposers is strongly encouraged. In addition, National Science Foundation Update is a free e-mail subscription service designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF Regional Grants Conferences. Subscribers are informed through e-mail when new publications are issued that match their identified interests. Users can subscribe to this service by clicking the "Get NSF Updates by Email" link on the NSF web site.

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this new mechanism. Further information on Grants.gov may be obtained at http://www.grants.gov.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 40,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

Facilitation Awards for Scientists and Engineers with Disabilities provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See Grant Proposal Guide Chapter II, Section D.2 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at http://www.nsf.gov

- **Location:** 4201 Wilson Blvd. Arlington, VA 22230
- **For General Information** (NSF Information Center)**:** (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**

  Send an e-mail to: nsfpubs@nsf.gov

  or telephone: (703) 292-7827
- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to

the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004), and NSF-51, "Reviewer/Proposal File and Associated Records, " 69 Federal Register 26410 (May 12, 2004). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

Suzanne H. Plimpton
Reports Clearance Officer
Division of Administrative Services
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