Enabling Discovery through GEnomic Tools (EDGE)

PROGRAM SOLICITATION
NSF 20-532

REPLACES DOCUMENT(S):
NSF 19-527

National Science Foundation

Directorate for Biological Sciences
Division of Integrative Organismal Systems

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

Proposals Accepted Anytime

IMPORTANT INFORMATION AND REVISION NOTES

Revisions:

The two tracks for submission have changed. They now are:

FUNCTIONAL GENOMIC TOOLS TRACK: for proposals aimed at developing tools for gene manipulation and/or phenotyping, analytical approaches or infrastructure to overcome one or more blocks to direct tests of gene function on demand; this track combines the comprehensive and targeted tracks from the previous EDGE solicitation.

COMPLEX MULTIGENIC TRAITS TRACK: for proposals focused on hypothesis driven research to understand causal mechanisms connecting genomes and complex multigenic organismal phenomes across a variety of environmental, developmental, social, and/or genomic contexts.

INQUIRIES about either track can be sent to BIOEDGE@nsf.gov.

Submission deadlines have been removed; EDGE proposals will now be accepted anytime.

Important Reminders:

Multi-institutional collaborative proposals **must** be submitted as a single proposal with one eligible organization serving as the lead and all other organizations as subawardees. Separately submitted collaborative proposals will be returned without review. International subawards are permitted if justified by unique opportunities and capabilities not available in the U.S.

Any proposal submitted in response to this solicitation should be submitted in accordance with the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG).

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Enabling Discovery through GEnomic Tools (EDGE)

Synopsis of Program:

The Enabling Discovery through GEnomic Tools (EDGE) program supports genomic research that addresses the mechanistic basis of complex traits in diverse organisms within the context (environmental, developmental, social, and/or genomic) in which they function. The EDGE program also continues to support the development of innovative tools, technologies, resources, and infrastructure that advance biological research focused on the identification of the causal mechanisms connecting genes and phenotypes. EDGE is designed to provide support for (1) the development of tools, approaches, and infrastructure aimed at testing cause and effect hypotheses between gene function and phenotypes in diverse plants, animals, microbes, viruses, or fungi for which these methods are presently unavailable, and (2) hypothesis-driven research that tests cause and effect relations between genotype(s) and phenotypes in non-model plants, animals, microbes, viruses, or fungi.

These goals are essential to uncovering the rules that underlie genomes-to-phenomes relationships, an area relevant to Understanding the Rules of Life: Predicting Phenotype, one of the 10 Big Ideas for future NSF investment.

Cognizant Program Officer(s):

Please note that the following information is current at the time of publishing. See program website for any updates to the points of contact.

- Theodore (Ted) J. Morgan, telephone: (703) 292-7868, email: tmorgan@nsf.gov
- Edda (Floh) Thiels, telephone: (703) 292-8167, email: ethiels@nsf.gov
- Douglas K. (Patrick) Abbot, telephone: (703) 292-7820, email: dabbot@nsf.gov
- Ford Ballantyne, telephone: (703) 292-8037, email: fballant@nsf.gov
- Steven E. Ellis, telephone: (703) 292-7876, email: stellis@nsf.gov
- Anthony G. Garza, telephone: (703) 292-8440, email: aggarza@nsf.gov
- Diane Jofuku Okamuro, telephone: (703) 292-4508, email: dokamuro@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: 10 to 15

Approximately 10-15 awards per year, pending availability of funds

Anticipated Funding Amount: $10,000,000

$10,000,000 in FY2020. The estimated budget, number of awards, and average award size/duration are subject to the availability of funds.

Limitation of Awards

EDGE proposal budget requests may be for up to $2 million to support up to a four-year project plan.

Eligibility Information

Who May Submit Proposals:

The categories of proposers eligible to submit proposals to the National Science Foundation are identified in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG), Chapter I.E. Unaffiliated individuals are not eligible to submit proposals in response to this solicitation.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI:

There are no restrictions or limits.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not required
- **Preliminary Proposal Submission:** Not required
- **Full Proposals:**
    - Full Proposals submitted via FastLane: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
    - Full Proposals submitted via Research.gov: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?

ods_key=pappg.
    - 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: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide).

B. Budgetary Information

- **Cost Sharing Requirements:**

  Inclusion of voluntary committed cost sharing is prohibited.

- **Indirect Cost (F&A) Limitations:**

  Not Applicable

- **Other Budgetary Limitations:**

  Other budgetary limitations apply. Please see the full text of this solicitation for further information.

C. Due Dates

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

  Proposals Accepted Anytime

Proposal Review Information Criteria

Merit Review Criteria:

National Science Board approved criteria. Additional merit review criteria 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

In recognition that a lack of tools, approaches, associated infrastructure, and research in functional genomics and high-throughput phenotyping remained a significant impediment to our understanding of the relationship between genomes and phenomes and ultimately predicting phenotypes, the Division of

Integrative Organismal Systems (IOS) began the EDGE program in 2016.

Although many more organisms and their research communities are genomically enabled now compared to when the EDGE program began, challenges remain. A comprehensive understanding of genotype-to-phenotype relationships requires that functional genomics move beyond a focus on candidate genes and single-gene manipulation for genes of large effect to a focus on complex multigenic traits. Achieving such understanding will require pursuing systems-level analyses of gene-regulatory networks and the functional properties that emerge from them, while elucidating the causal connections across levels of biological organization. To achieve these goals, the EDGE program provides support for genomic research and associated theory, approaches, tools, and infrastructure development to address the mechanistic basis of complex traits in diverse organisms within the context (environmental, developmental, social, and/or genomic) in which they function.

With this solicitation IOS is joined by the Division of Biological Infrastructure, the Division of Environmental Biology, and the Division of Molecular and Cellular Biosciences in support of tool development and research to solve the grand challenge of uncovering the rules that guide the genomes-to-phenomes relationship. Solving this grand challenge is necessary to achieving the goals of Understanding the Rules of Life: Predicting Phenotype, one of the 10 Big Ideas for future NSF investment.

NEW in this competition is a hypothesis-driven research track to support research and integrated theory and analysis development focused on determining the generalizable principles that connect genotypes and phenotypes in diverse organisms and across contexts (environmental, developmental, social and/or genomic).

All IOS programs also encourage proposals that leverage NSF-supported scientific infrastructure, including but not limited to cyberinfrastructure (e.g. Cyverse, Environmental Data Initiative), and infrastructure for accurately monitoring the organism's natural environment (e.g. the National Ecological Observatory Network (NEON), National Ocean Observatories, Critical Zone Observatories).

II. PROGRAM DESCRIPTION

A comprehensive understanding of the functional mechanisms that connect genotype-to-phenotypes is a grand challenge in biology. Support for research on diverse organisms is critical for developing strong inferences about the rules governing the mechanisms that bidirectionally connect genomes and phenomes. The objective of the EDGE program is to provide support for genetic and/or genomic research and associated theory, approach, tool, and infrastructure development that address the mechanistic basis of complex traits in diverse organisms within the context (environmental, developmental, social, and/or genomic) in which they function.

The EDGE program will accept proposals to two submission tracks:

FUNCTIONAL GENOMIC TOOLS TRACK: Proposals submitted to this track should propose to develop and provide proof-of-concept tests of functional genomic tools and infrastructure to enable direct tests of hypotheses about gene function in diverse plants, animals, microbes, viruses or fungi for which such tools and infrastructure are presently unavailable.

With the FUNCTIONAL GENOMIC TOOLS TRACK, the EDGE program continues to focus on the development of functional genomic tools, methods, approaches, and associated infrastructure to enable communities to identify the genomic basis of complex traits and predict phenotypes in diverse organisms presently lacking such tools. The selected organisms should be well suited for research across disciplines within the organismal biology.

PIs may use taxonomic, question-based, and/or technology-based strategies to develop tools and approaches that will be employed by larger communities of researchers. Projects may include instrumentation development followed by proof-of-concept testing in the context of developing functional genomic tools to enable direct tests of gene function in organisms for which such tools and infrastructure are presently lacking.

Tools, approaches, and infrastructure that will have significant catalytic effects to enable large numbers of investigators in organismal biology to overcome bottlenecks in directly testing gene function will receive priority. The FUNCTIONAL GENOMIC TOOLS TRACK proposals **must** include carefully developed plans for rapid and active dissemination of any new resources and training of other researchers in their use, as well as a rationale for support that is based on an assessment of current impediments and the potential impact of proposed projects on the relevant research communities. Investigators are encouraged to bring together novel combinations of expertise to achieve the greatest impact of the proposed tools and infrastructure across research communities.

Proposals submitted to the FUNCTIONAL GENOMICS TOOLS TRACK benefit from an existing community of researchers using the target organism. Although proposals can be submitted and implemented by single investigators, participation in formulation of the proposal by members of the user community is recommended. This community should be clearly described in the "Research Community Impact" section of the project description. The EDGE program does not support research on the promise that a research community will form around an organism once functional genomic tools become available as a result of investment by this program.

Examples of relevant objectives for plants, animals, microbes, viruses or fungi for which such tools and infrastructure are presently unavailable include, but are not limited to:

- Development of mutant libraries and/or high-quality reference genomes
- Expansion of the use of gene editing, knock-out, and overexpression approaches for manipulating individual genes or interrogating multiple genes simultaneously in diverse organisms;
- Development of approaches to test gene function in a variety of targeted, single cells in organisms;
- Generalizable high throughput phenotyping methods;
- Innovative approaches for establishing function of single or networks of genes; and
- Development and testing of transformation approaches.

COMPLEX MULTIGENIC TRAITS TRACK: Prior investments of the EDGE program have led to more wide-spread examination of genome(s)-to-phenome(s) relationships in many emerging model plants, animals, microbes, viruses and fungi. However, in these systems functional genomics has largely been limited to identifying candidate genes followed by single gene manipulation. Although, single gene manipulation allows interrogation of genes of large effect it does not significantly advance our understanding of complex multigenic organismal traits across a variety of contexts (i.e. environmental, developmental, social and/or genomic). The EDGE program recognizes that many of the traits of interest to biologists are quantitative in nature and are controlled by many genes of small effect and that understanding complex traits requires systems-level analysis of the underlying gene regulatory

networks that goes beyond linking individual genes with said traits.

With the MULTIGENIC TRAITS track the EDGE program broadens its scope to include hypothesis-driven research that advances understanding of the relationship between genomes and complex multi-genic organismal traits, toward the goal of predicting organismal phenotypes across diverse contexts, including environmental, developmental, social, and/or genomic contexts. Successful proposals include development of theory and/or analytical approaches to achieve the scientific goal.

For the COMPLEX MULTIGENIC TRAITS TRACK, the use of traditional model organisms is permitted, but proposals **must** include complementary experiments in an emerging organism to demonstrate the **generalizability** of the results in diverse organisms across contexts (environmental, developmental, social, and/or genomic).

Submissions to this track may include but are not limited to:

- Systems-level analysis of the gene regulatory networks underlying complex traits;
- Elucidation of the causal connections across levels of biological organization that underlie complex multigenic traits;
- New or innovative analytical approaches to linking genes and complex traits; and
- Multi-genome/epigenome interactions with the environment towards the goal of predicting complex organismal phenotypes across contexts.

INFORMATION FOR BOTH TRACKS:

Highly competitive EDGE proposals submitted to either track will present a compelling case for the potential of the project to enable or achieve direct tests of hypotheses about gene function in diverse emerging organism(s) in order to accelerate advances in cellular, organismal, and evolutionary biology.

The EDGE program will support projects from individual investigators, small groups of collaborators, or larger collaborative teams. Projects that cross disciplines within biology, combining organismal biology with cellular, evolutionary or ecological research will be given higher priority.

Budget requests should be commensurate with the goals of the project. The EDGE program expects to make awards covering the full range of budget requests commensurate with the size and scope of each project.

EDGE DOES **NOT** SUPPORT:

CURRENT OR NEW MODEL ORGANISMS: The EDGE program does not provide support for development or refinement of tools for already existing model organisms such as *Mus, Caenorhabditis, Arabidopsis, Drosophila, yeast, etc., or crop models such as maize, rice, wheat, tomato, soybean, etc.,* unless the tool developed in this organism will be used to **generalize** the approach or biological principle to other organisms.

RESEARCH AND TOOL DEVELOPMENT SUPPORTED ELSEWHERE: The EDGE program does not support proposals that are appropriate for the Plant Genome Research program or other federal agencies. Investigators wishing to work on genome-enabled and well-resourced plants for which genetic and functional genomic tools already exist are encouraged to contact the Plant Genome Research Program to discuss appropriate programmatic fit.

SEQUENCING, BIOINFORMATICS AND IN SILICO BIOLOGY: Proposals that seek support exclusively for initial sequencing of an organism's genome, or bioinformatics tool and pipeline development are not appropriate for EDGE. Likewise, projects that focus exclusively on in silico approaches to infer gene function, i.e., generating hypotheses about gene function, identifying candidate genes or regions of the genome without direct tests of those hypotheses, are **not** appropriate for EDGE.

Proposals for which any of the above apply may be returned without review.

SPECIAL PROPOSAL TYPES:

Research in Undergraduate Institution (RUI) Proposals: Proposals led by PIs from Primarily Undergraduate Institutions should be submitted through the RUI/ROA solicitation (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5518). In addition to the requirements of the RUI program, proposals should follow the guidance in this solicitation.

NSF-BSF Proposals: The EDGE program will accept proposals for the joint NSF/US-Israel Binational Science Foundation (BSF) collaborative research opportunity. More information can be found in the Dear Colleague Letter at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf17120 and subsequent replacements.

III. AWARD INFORMATION

Anticipated Type of Award: Continuing Grant or Standard Grant

Estimated Number of Awards: Approximately 10-15 awards per year, pending availability of funds

Anticipated Funding Amount: $10,000,000 in FY2020. The estimated budget, number of awards, and average award size/duration are subject to the availability of funds.

Limitation of Awards: EDGE proposal budgets may not exceed $2 million to support up to a four-year project plan.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

The categories of proposers eligible to submit proposals to the National Science Foundation are identified in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG), Chapter I.E. Unaffiliated individuals are not eligible to submit proposals in response to this solicitation.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI:

There are no restrictions or limits.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

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

- 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 Proposal & Award Policies & Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 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 Research.gov: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal and Award Policies and Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov. The Prepare New Proposal setup will prompt you for the program solicitation number.
- 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: (https://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) 292-8134 or by e-mail from nsfpubs@nsf.gov.

See PAPPG Chapter II.C.2 for guidance on the required sections of a full research proposal submitted to NSF. Please note that the proposal preparation instructions provided in this program solicitation may deviate from the PAPPG instructions.

EDGE SPECIFIC PROPOSAL PREPARATION INSTRUCTIONS

The following solicitation-specific exceptions and additions to the PAPPG and NSF Grants.gov Application Guide guidelines apply to proposals submitted to this solicitation:

Collaborative Proposals: When a consortium of eligible organizations submits a proposal, it must be submitted as a single proposal with one organization serving as the lead and all other organizations as subawardees. Separately submitted collaborative proposals will be returned without review.

Title of Proposed Project. The project title must start with "**EDGE FGT**: ..." for the FUNCTIONAL GENOMIC TOOLS track OR "**EDGE CMT:**…" for the COMPLEX MULTIGENIC TRAITS track.

Project Description. The project description must not exceed 15 pages. Project plans must span **four** years or less. Investigators should note the additional review criteria for EDGE proposals contained in this solicitation (see Additional Solicitation Specific Review Criteria) as they develop their proposals.

The Project Description must contain, but is not limited to, the following **three named sub-sections in any order :**

- **Intellectual Merit** This named sub-section of the Project Description is required in all proposals submitted to NSF.
- **Experimental Approach** This section should include but is not limited to: a description of the proposed work, including goals, strategies, approaches, and methods. Highly competitive EDGE proposals include, for example, positive and negative controls, relevant repeatability metrics, and transformation efficiencies. Include only aims that are relevant to the goals of the EDGE program.
- **Broader Impacts** This named sub-section of the Project Description is required in all proposals submitted to NSF.

Submission to the Functional Genomics Tools track should also include a 4th subsection entitled:

Research Community Impact This section should include but is not limited to: a discussion of the scientific and community-based justification of the selection of organism(s) that will be enabled; clear statements identifying bottlenecks to functional genomics questions linking cause and effect in these organisms, and a description of how the bottlenecks will be addressed; a description of how one or more research communities within organismal biology and, if applicable, beyond will benefit from the proposed project; a description of how scientific progress will be accelerated in one or more research areas if the proposed project is successful; a description of scientific gaps or specific scientific questions that could be addressed if the proposed tools, approaches or infrastructure were developed for functional genomic studies in the focal organism(s); and a description of any impediments the communities may face in employing the proposed tools, approaches or outcomes.

EDGE proposals that do not include the required named sub-sections in the Project Description will be returned without review.

Proposal Budget Provide a summary budget and a yearly budget for the duration of the proposed project, including subawards, if appropriate. A Budget Justification should be provided for each budget submitted, including any subaward budgets. It is recommended that the Budget Justifications be structured with the same headings and subheadings shown in the Budget sheets. Funds for facility support, construction, or renovation may not be requested.

The budget **must** include funds to cover the cost of attendance of the principal investigator and one other member of the project senior personnel, or one trainee (graduate student or postdoctoral researcher) at a two-day annual awardee meeting for **all** funded years.

SUPPLEMENTARY DOCUMENTS

PAPPG Required Supplementary Documents EDGE proposals are required to have data management plans, postdoctoral mentoring plans and additional supplementary documents as described in the PAPPG.

Project Management Plan For those projects that involve one or more organizations as subawardees of the lead organization, a Project Management Plan, not to exceed 3 pages, **must** be included as a Supplementary Document. The plan should include a description of communication and coordination mechanisms that will insure the project goals are met in a timely manner. This document is separate from the Data Management Plan required in all NSF proposals (see the PAPPG). Proposals that involve one or more organizations as subawardees and that do not include the required Project Management Plan *will be returned without review*.

Letters of Collaboration Supplementary Documents may include letters of collaboration from individuals or organizations that are ***integral parts of the proposed project but are not supported by subawards.*** Such individuals or organizations may be involved in specific, well-defined aspects of the project, cooperation on outreach efforts, or documentation of permission to access materials or data. Letters of collaboration should be limited to stating the intent to collaborate and should not contain endorsements or evaluation of the proposed project. The recommended format in the PAPPG for letters of collaboration can be found in Chapter II.C.2.j of the PAPPG.

The Project Description should include a description of the nature of and need for the collaboration, the role of the collaborator, and the expected outcomes/deliverables from the collaboration. Letters of collaboration are not required from any individual designated as Co-PI or senior personnel, nor are letters of collaboration required from any organization that will be a subawardee in the proposal budget.

Requests to collaborators for letters of collaboration should be made by the PI well in advance of the proposal submission deadline because they **must** be included at the time of proposal submission.

Generic letters of general support are not allowed.

Submissions to the **Functional Genomic Tools Track** must also include:

Dissemination and Education Plan A Dissemination and Education Plan, not to exceed 3 pages, must be included as a Supplementary Document. The Dissemination and Education Plan should include, but is not limited to, a description of how the enabling tools will be rapidly disseminated and how training will be provided (if necessary) to maximize impact on the research community. An explicit expectation is that tools and methods will be disseminated before publication; PIs should include plans to accommodate this expectation. How will outreach to the community be achieved? How many researchers will be trained? How will reagents and other resources be maintained and disseminated? An implementation timetable and strategy for evaluation and management of the Dissemination and Education Plan over the award period (four years or less) should be included. **Proposals that do not include the required Dissemination and Education Plan *will be returned without review***.

PRE-SUBMISSION CHECKLIST

In addition to the PAPPG Proposal Preparation Checklist, please review your proposal against this checklist to ensure that it is also fully compliant with the guidelines provided in this solicitation:

- The EDGE program solicitation number has been included in the program solicitation block on the NSF Cover Sheet, and the title of the proposal begins with “EDGE FGT:...” or “EDGE CMT:…” .
- In addition to the section labeled “Broader Impacts”, the Project Description also includes an additional separate section labeled “Experimental Approach”. For proposals submitted to the FUNCTIONAL GENOMICS TOOLS track, the Project Description includes a 4th separate section labeled “Research Community Impact,” as described above.
- Planned REU, ROA, RET, and RAHSS activities are included in the budget request.
- Funds to cover the cost of attendance of the PI and one other member of the project senior personnel or one trainee (graduate student or postdoctoral researcher) at an awardee meeting are included in the budget for all funded years.
- The Data Management Plan, and, if applicable, Dissemination and Education Plan, Project Management Plan, Postdoctoral Mentoring Plan, RUI Impact Statement and RUI Certification, and/or REU Supplement Request have been uploaded into Supplementary Documents.
- Letters of Collaboration (where applicable) conform to the recommended template and are uploaded into Supplementary Documents.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Other Budgetary Limitations:

EDGE proposal budget requests may be for up to $2 million to support up to a four-year project plan

C. Due Dates

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

  Proposals Accepted Anytime

D. FastLane/Research.gov/Grants.gov Requirements

For Proposals Submitted Via FastLane or Research.gov:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: https://www.fastlane.nsf.gov/a1/newstan.htm. To prepare and submit a proposal via Research.gov, see detailed technical instructions available at: https://www.research.gov/research-portal/appmanager/base/desktop?_nfpb=true&_pageLabel=research_node_display&_nodePath=/researchGov/Service/Desktop/ProposalPreparationandSubmission.html. For FastLane or Research.gov user support, call the FastLane and Research.gov Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov or rgov@nsf.gov. The FastLane and Research.gov Help Desk answers general technical questions related to the use of the FastLane and Research.gov systems. 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.

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. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: https://www.grants.gov/web/grants/applicants.html. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical 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.

Proposers that submitted via FastLane or Research.gov may use Research.gov to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program for acknowledgement and, if they meet NSF requirements, for review. 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 either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with 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. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in PAPPG Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: https://www.nsf.gov/bfa/dias/policy/merit_review/.

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Building the Future: Investing in Discovery and Innovation - NSF Strategic Plan for Fiscal Years (FY) 2018 – 2022*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

One of the strategic objectives in support of NSF's mission is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions must recruit, train, and prepare a diverse STEM workforce to advance the frontiers of science and participate in the U.S. technology-based economy. NSF's contribution to the national innovation ecosystem is to provide cutting-edge research under the guidance of the Nation's most creative scientists and engineers. NSF also supports development of a strong science, technology, engineering, and mathematics (STEM) workforce by investing in building the knowledge that informs improvements in STEM teaching and learning.

NSF's mission calls for the broadening of opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, which 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.

A. Merit Review Principles and Criteria

The National Science Foundation strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs in understanding across all areas of science and engineering research and education. To identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF makes every effort to conduct a fair, competitive, transparent merit review process for the selection of projects.

1. Merit Review Principles

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities.

These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

2. Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (PAPPG Chapter II.C.2.d(i). contains additional information for use by proposers in development of the Project Description section of the proposal). Reviewers are strongly encouraged to review the criteria, including PAPPG Chapter II.C.2.d(i), prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to
    a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
    b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. NSF values the advancement of scientific knowledge and activities that contribute to achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

Proposers are reminded that reviewers will also be asked to review the Data Management Plan and the Postdoctoral Researcher Mentoring Plan, as appropriate.

Additional Solicitation Specific Review Criteria

For EDGE proposals, it is suggested that reviewers focus on the following critical aspects of the proposed work:

- The potential catalytic impact on advancing research and on associated research communities toward understanding genome-to-phenome

relationships across levels of analysis and across biotic and abiotic contexts;
- The feasibility of the proposed methods and approaches to achieve the stated goals and the likelihood of success;
- For proposals involving multiple organizations: the quality of the Project Management Plan and likelihood of successful project coordination; and
- For proposals submitted to the FUNCTIONAL GENOMIC TOOLS track: the quality and potential for rapid and high impact of the Dissemination and Education Plan.

B. Review and Selection Process

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

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will generally be completed and submitted by each reviewer and/or panel. 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 strives to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

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. After an administrative review has occurred, Grants and Agreements Officers perform 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.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any reviewer-identifying information, 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.

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 notice, 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 notice; (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 notice. 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 https://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 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 *Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

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 no later than 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). No later than 120 days following 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 all identified PIs and co-PIs on a given award. 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 Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also 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.

More comprehensive information on NSF Reporting Requirements and other important information on the administration of NSF awards is contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

VIII. AGENCY CONTACTS

Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.

General inquiries regarding this program should be made to:

- Theodore (Ted) J. Morgan, telephone: (703) 292-7868, email: tmorgan@nsf.gov
- Edda (Floh) Thiels, telephone: (703) 292-8167, email: ethiels@nsf.gov
- Douglas K. (Patrick) Abbot, telephone: (703) 292-7820, email: dabbot@nsf.gov
- Ford Ballantyne, telephone: (703) 292-8037, email: fballant@nsf.gov
- Steven E. Ellis, telephone: (703) 292-7876, email: stellis@nsf.gov
- Anthony G. Garza, telephone: (703) 292-8440, email: aggarza@nsf.gov
- Diane Jofuku Okamuro, telephone: (703) 292-4508, email: dokamuro@nsf.gov

For questions related to the use of FastLane or Research.gov, contact:

- FastLane and Research.gov Help Desk: 1-800-673-6188

  FastLane Help Desk e-mail: fastlane@nsf.gov.

  Research.gov Help Desk e-mail: rgov@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.

General inquiries regarding this program should be made to:

BIOIOSEDGE@NSF.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, "NSF Update" is an information-delivery system 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 Grants Conferences. Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on NSF's website.

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this mechanism. Further information on Grants.gov may be obtained at https://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 55,000 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 Arctic 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 (FASED) provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See the *NSF Proposal & Award Policies & Procedures Guide* Chapter II.E.6 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 https://www.nsf.gov

- **Location:** 2415 Eisenhower Avenue, Alexandria, VA 22314
- **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) 292-8134
- **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 System of Record Notices, NSF-50, "Principal Investigator/Proposal File and Associated Records," and NSF-51, "Reviewer/Proposal File and Associated Records." 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:

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