GERMINATION: Germination of Research Questions for Addressing Critical Societal Challenges

PROGRAM SOLICITATION
NSF 21-594

National Science Foundation

Directorate for Engineering
    Emerging Frontiers and Multidisciplinary Activities

Letter of Intent Due Date(s) *(required)* (due by 5 p.m. submitter's local time):

August 27, 2021

For proposals that will be submitted to the GERMINATION Expansion track, LOI submission through FastLane is required. For proposals that will be submitted to the GERMINATION Innovation track, a research concept outline must be submitted by Email.

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

October 29, 2021

IMPORTANT INFORMATION AND REVISION NOTES

Letters of Intent submitted in response to this solicitation should be submitted in accordance with the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 20-1), which is effective for proposals submitted, or due, on or after June 1, 2020.

Full Proposals submitted in response to this solicitation should be submitted in accordance with the revised PAPPG (NSF 22-1), which is effective for proposals submitted, or due, on or after October 4, 2021.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

GERMINATION: Germination of Research Questions for Addressing Critical Societal Challenges

Synopsis of Program:

Engineers and scientists are capable of making enormous impact when they conceive and conduct fundamental research that addresses societal needs. Our world faces many critical challenges engendered in part by the expanding and aging world population, including meeting global needs for food, energy, water, land, and other resources, while respecting and maintaining the balance of our planetary ecosystem. Other notable challenges include addressing climate change; maintaining cybersecurity, privacy, and fairness in our increasingly connected world; and providing, maintaining and protecting infrastructure. All of these represent potentially large and fertile opportunities for science, technology, engineering and mathematics (STEM) research to serve society.

The NSF Directorate for Engineering GERMINATION program aims to foster the development of pedagogical frameworks, platforms and/or environments to enable participants to formulate research questions and ideas with potentially transformative outcomes. The extraordinary response of the STEM research community to the COVID-19 pandemic, exemplified by the record-breaking speed of novel vaccine development, highlights the outstanding capabilities at all levels of the research enterprise. The GERMINATION program seeks to harness the immense capacities of academic researchers to similarly address other critical global challenges through supporting the development of new pedagogical approaches that train researchers to formulate and develop key research questions.

The GERMINATION program invites proposals to design, test, evaluate and implement pedagogical frameworks, platforms and/or environments that enable participants to formulate research questions and ideas that have the potential to address critical societal challenges. In order to catalyze development of novel approaches, while simultaneously expanding the reach of pilot approaches which are already exhibiting promise, two tracks will be supported in Fiscal Year (FY) 2022: **GERMINATION Innovation** and **GERMINATION Expansion**. **GERMINATION Innovation** awards will fund projects to design, test and evaluate previously unexplored pedagogical frameworks, platforms and/or environments that have the explicit goal of enabling the participants to formulate research questions with potentially transformative outcomes. Projects submitted to the Innovation track must use the EArly-concept Grants for Exploratory Research (EAGER) proposal type (see PAPPG Chapter II). **GERMINATION Expansion** awards will fund projects that focus on development, implementation and scaling of

evidence-based strategies for achieving GERMINATION goals. Projects supported under the Expansion track should focus on scaling previously piloted approaches with demonstrated efficacy to a regional or national sphere of activity, and will likely involve development of new collaborative relationships to establish networks capable of implementation beyond the pilot institution.

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.

- Louise R. Howe, Program Director, telephone: (703) 292-2548, email: lhowe@nsf.gov

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

- 47.041 --- Engineering

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 8 to 10

4-5 GERMINATION Innovation awards (EAGERs) and 4-5 GERMINATION Expansion awards depending on funding availability and quality of proposals received.

Anticipated Funding Amount: $3,000,000

4-5 GERMINATION Innovation awards are anticipated; the budget for GERMINATION Innovation proposals is between $100,000 and $300,000 total for a duration of one to two years. These GERMINATION Innovation awards will be made using the EAGER proposal type. 4-5 GERMINATION Expansion awards are anticipated; the budget for GERMINATION Expansion proposals is up to $500,000 total for a duration of up to three years.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

Who May Serve as PI:

There is no constraint on the role of the Principal Investigator (PI) within the submitting organization. However, the proposal must document the PI's experience with, and commitment to, leading a culture of change and the team's experience in mentoring academics of the category that will be involved as participants in the proposed pedagogical framework, platform or environment.

Inclusion of appropriate social science expertise (e.g., organizational psychologists and evaluation professionals) in the leadership team is highly recommended.

Limit on Number of Proposals per Organization: 1

Only 1 proposal may be submitted by a single organization.

Limit on Number of Proposals per PI or co-PI: 1

Individuals may participate as either PI or co-PI in only one proposal submitted to this solicitation.

If an individual is listed as PI or co-PI on more than one proposal to this solicitation, all proposals in excess of the limit for any person will be returned without review in the reverse order received.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Submission of Letters of Intent is required for proposals submitted under the GERMINATION Expansion track. Please see the full text of this solicitation for further information.

- **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 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

- **Letter of Intent Due Date(s)** *(required)* (due by 5 p.m. submitter's local time):

  August 27, 2021

     For proposals that will be submitted to the GERMINATION Expansion track, LOI submission through FastLane is required. For proposals that will be submitted to the GERMINATION Innovation track, a research concept outline must be submitted by Email.

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

  October 29, 2021

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:

Additional award conditions apply. Please see the full text of this solicitation for further information.

Reporting Requirements:

Standard NSF reporting requirements apply.

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I. INTRODUCTION

Through the GERMINATION program, the NSF Directorate for Engineering seeks to foster the development of innovative approaches that enable STEM researchers to formulate research questions and ideas with potentially transformative outcomes. Numerous societal challenges indicate the pressing need for impactful fundamental science and engineering research to provide solutions. Continuing expansion of the world population necessitates imagining new ways of using our natural resources and technological abilities to provide food, water, energy, shelter, clean air and sanitation for people worldwide. Increasing human life expectancy intensifies the need for new approaches to aging-associated social and healthcare challenges. Computing and information technologies have drastically altered our daily lives, but increased connectivity and information access generate not only solutions but also new problems. To address such complex challenges, engineers and scientists must consciously design their research programs with clear focus on their desired outcomes; central to this process is the articulation of compelling research questions. Questions have been described as "*the engines of intellect, the cerebral machines which convert energy to motion, and curiosity to controlled inquiry.*"[1] Leading innovators worldwide have been suggested to share an uncommon ability to ask questions, with many innovators crediting specific questions as the catalysts for their breakthrough discoveries.[2]

The GERMINATION program seeks to understand whether pedagogical frameworks can be developed to train academics to formulate research questions that result in transformative impacts on key societal needs. Specifically, the GERMINATION program funds development of innovative frameworks, platforms and/or environments that increase the ability of academic researchers, from graduate students through to mid-senior career faculty, to develop research questions. The platforms are expected to encompass creation and implementation of tools, resources and training activities to promote development of key skills and mindsets that increase the capacity of participants to formulate novel research questions with substantive potential for impact. An important consideration is the potential for scalability of GERMINATION approaches beyond the initial institutional test-bed site.

[1] David Hackett Fischer, Historians' Fallacies: Toward a Logic of Historical Thought, 1970, Harper and Row.

[2] Warren Berger, A More Beautiful Question: The Power of Inquiry to Spark Breakthrough Ideas, 2014, Bloomsbury.

II. PROGRAM DESCRIPTION

The NSF/Engineering GERMINATION program invites proposals to design, test, evaluate and implement pedagogical frameworks, platforms and/or environments that enable participants to formulate research questions and ideas with potentially transformative outcomes. Since FY 2016, the NSF Directorate for Engineering has funded several pilot projects as part of the GERMINATION program; pilot approaches ranged from prototyping of faculty development programs aimed at research transformation to training graduate students in the skill of question formulation itself. In order to continue to catalyze exploration and development of new frameworks, while simultaneously expanding the reach of pilot approaches which have exhibited promise, two tracks will be supported in FY 2022: GERMINATION Innovation and GERMINATION Expansion.

GERMINATION Innovation projects will design, test and evaluate novel pedagogical approaches with the goal of enabling the participants to formulate research questions with potentially transformative outcomes. These projects will be supported via the EArly-concept Grants for Exploratory Research (EAGER) proposal type (see PAPPG Chapter II). Requests may be for $100-300K and a duration of one to two years. EAGERs are typically funded at $100K for one year, with the possibility of renewal. Investigators who have previously received a GERMINATION EAGER are not eligible to receive a GERMINATION Innovation award. **Investigators interested in submitting a GERMINATION Innovation proposal must submit a two-page research concept outline explaining the core idea of their project to the cognizant Program Officer and obtain permission prior to submission of an EAGER proposal.**

GERMINATION Expansion projects will focus on development, implementation and scaling of evidence-based strategies for achieving GERMINATION goals. Proposals submitted to this track may request up to $500K and be up to three years in duration. Projects supported under the Expansion track should focus on scaling previously piloted approaches to a regional or national sphere of activity. Prior exploratory studies may have been conducted with NSF support, but this is not a requirement for consideration for support under this solicitation. All proposals should include data supporting the efficacy of the proposed approach, as well as convincing plans to scale beyond the institution at which the approach has previously been successfully piloted. GERMINATION Expansion proposals may be viewed as conceptually similar to Research Coordination Network (RCN) proposals inasmuch as they have the goals of fostering new collaborations, and of leveraging networking strategies and collaborative technologies to develop a new field. However, for GERMINATION proposals, the central goal must be to implement at scale evidence-based pedagogical approaches to train academics to formulate research questions with genuine potential for societal impact.

For both tracks, proposers are strongly encouraged to design their approaches as creatively as possible, but approaches should be grounded in relevant existing knowledge from the social and behavioral sciences and/or science of research organizations. **Inclusion of appropriate social science expertise in the research team is strongly recommended.**

Proposals to both tracks are encouraged to incorporate in their programs and/or nurture in their participants characteristics known to be associated with productive and innovative research. For example, inclusion of diverse perspectives, both inherent and acquired, is known to positively influence outcomes in both science and innovation.[3-6] Publication strength, assessed by citation frequency and journal impact factor, has been positively associated with ethnic heterogeneity,[3] and with interdisciplinary expertise.[4] Furthermore, socially diverse groups and leadership have been shown to correlate with improved decision making, increased innovation, and superior business performance.[5,6] Benefits of heterogeneity include not only multiple perspectives but also altered information processing, presumably resulting in more powerful question framing. The importance of emotional and physical well-being for creativity and innovation is also attracting increasing attention. Holistic GERMINATION programs may benefit from incorporation of strategies to increase participant wellness.

Participants

Proposals submitted to both tracks should include STEM graduate students, postdoctoral researchers, and/or faculty as participants. Proposals should clearly identify the targeted participants. The proposed approaches should be designed to match the needs of the targeted participant type. Proposals should focus on the development of key skills and mindsets that will increase the capacity of participants to identify big opportunities, think creatively, and take intellectual risk to formulate novel research questions with potential to address societal challenges.

Evaluation

All proposals must include an evaluation plan which incorporates successful documentation and assessment of the effectiveness of the proposed approaches with respect to formulation of impactful research questions. GERMINATION teams must gather, analyze, evaluate and utilize data during development and implementation of these platforms to identify successful training strategies for leveraging and dissemination. **To this end, involvement of individuals with evaluation expertise in the leadership team is strongly encouraged**.

For **GERMINATION Innovation** proposals, submitters must include a plan to assess and document, in a meaningful way, the interim effectiveness of proposed approaches on (a) the participants in terms of how their ability and interest are enhanced in germinating research questions and ideas that address important societal needs; and (b) how likely it is for the proposed approaches to be scalable and adaptable beyond the institutions involved in the study.

For **GERMINATION Expansion** proposals, evaluation of longitudinal outcomes will form an essential component of the project and plans for this evaluation must be included in the proposal. Again, the central focus should be on how the ability and interest of the participants to germinate research questions and ideas that address important societal needs are enhanced.

[3] Richard B. Freeman and Wei Huang, Collaborating with People Like Me: Ethnic Coauthorship within the United States, *Journal of Labor Economics*, 33, no. S1 (Part 2, July 2015): S289-S318.

[4] Brian Uzzi, Satyam Mukherjee, Michael Stringer, and Ben Jones, Atypical Combination and Scientific Impact, 2013, *Science*, 342: 468-472.

[5] Sylvia A. Hewett, Melinda Marshall, and Laura Sherbin, How Diversity Can Drive Innovation, 2013, *Harvard Business Review*, https://hbr.org/2013/12/how-diversity-can-drive-innovation.

[6] Katherine W. Phillips, How Diversity Makes Us Smarter, 2015, *Scientific American*, https://www.scientificamerican.com/article/how-diversity-makes-us-smarter/#.

III. AWARD INFORMATION

Anticipated Type of Award: Continuing Grant or Standard Grant

Estimated Number of Awards: 8 to 10

4-5 GERMINATION Innovation awards (EAGERs) and 4-5 GERMINATION Expansion awards depending on funding availability and quality of proposals received.

Anticipated Funding Amount: $3,000,000

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Anticipated Funding Amount and number of awards are subject to the availability of funds.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

Who May Serve as PI:

There is no constraint on the role of the Principal Investigator (PI) within the submitting organization. However, the proposal must document the PI's experience with, and commitment to, leading a culture of change and the team's experience in mentoring academics of the category that will be involved as participants in the proposed pedagogical framework, platform or environment.

Inclusion of appropriate social science expertise (e.g., organizational psychologists and evaluation professionals) in the leadership team is highly recommended.

Limit on Number of Proposals per Organization: 1

Only 1 proposal may be submitted by a single organization.

Limit on Number of Proposals per PI or co-PI: 1

Individuals may participate as either PI or co-PI in only one proposal submitted to this solicitation.

If an individual is listed as PI or co-PI on more than one proposal to this solicitation, all proposals in excess of the limit for any person will be returned without review in the reverse order received.

Additional Eligibility Info:

Investigators who have previously received a GERMINATION EAGER are not eligible to receive an award under the **GERMINATION Innovation** track of this solicitation.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Letters of Intent *(required)*:

A two-page Letter of Intent (LOI) is required for proposals submitted to the GERMINATION Expansion track. LOIs are used by NSF to gauge the level of effort for review. They will not be used as pre-approval mechanisms for the submission of proposals, and no feedback will be provided to the submitters, *however Letters of Intent are required for all proposals submitted to the Expansion track of this solicitation*.

The Letter of Intent should be submitted through FastLane no later than the deadline specified in this solicitation. The subject heading of the letter should include the title of the proposal and the name of the lead organization. Each LOI must include the following:

- **Project Title:** The title must begin with "GERMINATION Expansion".
- **The Team:** 1) The name and departmental affiliation of the Principal Investigator (PI). 2) The name(s) and departmental affiliation(s) of the Co-PI(s) and all senior personnel. 3) The names(s) of any other (non-lead) participating institutions or organizations, including all sub-awardees.
- **Project Synopsis** (up to 700 words): Provide a brief summary of the project, including how it is expected to contribute towards achieving the goals of the GERMINATION program.

If multiple LOIs for a single project are submitted, the last one submitted before the deadline will be used. Each LOI is specific to the project, project title and PI.

An LOI submitted through FastLane is not required for EAGER proposals submitted to the GERMINATION Innovation track. Instead, prospective proposers must submit a two-page research concept outline by Email to the cognizant Program Officer by August 27, 2021 (5 p.m. submitter's local time) explaining the core idea of their project; and obtain Program Officer approval for submission of an EAGER proposal in response to this solicitation.

Letter of Intent Preparation Instructions:

When submitting a Letter of Intent through FastLane in response to this Program Solicitation please note the conditions outlined below:

- Submission by an Authorized Organizational Representative (AOR) is required when submitting Letters of Intent.
- A Minimum of 0 and Maximum of 4 Other Senior Project Personnel are permitted
- A Minimum of 0 and Maximum of 5 Other Participating Organizations are permitted
- Project Title is required when submitting Letters of Intent
- The Team is required when submitting Letters of Intent
- Project Synopsis is required when submitting Letters of Intent
- Submission of multiple Letters of Intent is permitted

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via FastLane 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 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.

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 FastLane. PAPPG Chapter II.D.3 provides additional information on collaborative proposals.

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.

GERMINATION Innovation Proposals

Concept Paper Requirement: Proposers who intend to submit an EAGER proposal to the GERMINATION Innovation track must submit a two-page research concept outline by Email to the cognizant Program Officer by August 27, 2021 (5 p.m. submitter's local time) explaining the core idea of their project; and obtain Program Officer approval for submission of an EAGER proposal in response to this solicitation.

If approved to submit to the Innovation track, proposers must follow the specific guidelines for EAGER proposals described in PAPPG Chapter II and the following supplemental instructions:

Proposal Title: The title must include the prefix "EAGER GERMINATION"

Project Description: GERMINATION Innovation proposals should be prepared in accordance with the guidance provided in the PAPPG. Additionally, these proposals should include within the Project Description:

Goals and Objectives: Clearly state what pedagogical framework, platform and/or environment will be piloted, together with goals for what this will achieve for the participants, as well as for the institution where appropriate.

Rationale and Context: Provide the rationale for the planned approach including prior supportive evidence or a motivating theory of change. Clearly articulate the underpinnings provided by relevant social science and/or education research.

Research Team: Provide a description of the constituent members of the research team, delineating what expertise each member brings to the project, and how their knowledge and skillsets will contribute to successful project outcomes.

Research and Evaluation Plan: GERMINATION Innovation projects must have a research plan that will enable the research team to effectively pilot **and** evaluate a novel pedagogical approach. A coherent evaluation plan is an essential component. Evaluation should include monitoring of the activities, to ensure the project stays on track, and also analysis of the outcomes of the project, using clearly reasoned metrics to understand the success of the piloted approach. Evaluation of outcomes should be designed to furnish data on whether the participants have increased ability, and interest, in germinating research questions and ideas that address important societal needs.

Barriers: Proposers are encouraged to identify potential cultural, structural, organizational, and/or individual barriers that may impede success of their approach, and to describe how these barriers will be addressed.

Roadmap for Scaling: The intended goal of GERMINATION Innovation projects is to lead to development of novel approaches to enhance the ability of academic researchers to formulate potentially impactful research questions. Ideally, successful piloted approaches will be succeeded by broader deployment within the research community. Proposals should therefore include a roadmap for how success in this pilot would be extended beyond the initial testbed to achieve regional or national impact.

GERMINATION Expansion Proposals

LOI Requirement: Proposers who intend to submit a proposal to the GERMINATION Expansion track must submit a two-page LOI through FastLane by August 27, 2021 (5 p.m. submitter's local time) as described above under "Letters of Intent".

Proposal Title: The title must include the prefix "GERMINATION Expansion"

Project Description: GERMINATION Expansion proposals should be prepared in accordance with the guidance provided in the PAPPG. Additionally, these proposals should include within the Project Description:

Goals and Objectives: Clearly state what pedagogical framework, platform and/or environment will be implemented, together with goals for what this will achieve for the participants, as well as for the institution where appropriate.

Rationale and Context: Provide the rationale for the planned approach including prior supportive evidence obtained in earlier studies which justifies development and expansion of the approach. In the absence of pilot data, a well-supported rationale for why the proposed approach is expected to yield successful outcomes is essential.

Research Team: The proposal should include a description of the constituent members of the research team, delineating what expertise each member brings to the project, and how their knowledge and skillsets will contribute to successful project outcomes. Previous experience with the proposed approach should be described.

Scaling: GERMINATION Expansion projects should provide a clear plan for their proposed study for scaling their approach beyond the original institutional testbed, including a consideration of how barriers identified in preliminary studies will be overcome during this larger scale implementation. Proposers should also identify, and discuss potential solutions to, novel challenges arising from deployment at scale.

Evaluation Plan: GERMINATION Expansion projects must have a coherent evaluation plan that will enable the research team to effectively evaluate their pedagogical approach. Evaluation should include monitoring of the activities, to ensure the project stays on track, and analysis of the outcomes of the project, using clearly reasoned metrics to understand the success of the scaled approach. Evaluation of outcomes should be designed to furnish data on whether the participants have increased ability, and interest, in germinating research questions and ideas that address important societal needs. Ideally metrics will have been established and validated during pilot studies.

Dissemination Plan: Provide a plan for disseminating the validated approaches from this study to other departments and institutions. Include discussion of challenges and strategies to adaptation in new settings.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Other Budgetary Limitations:

GERMINATION Innovation projects will be supported via the EAGER (EArly-concept Grants for Exploratory Research) mechanism. Budgets must be between $100,000 and $300,000 total for a duration of 1-2 years. **GERMINATION Expansion** proposals may request up to $500,000 total for a duration of up to three years.

Budget Preparation Instructions:

A Budget Justification prepared in accordance with the guidance in the PAPPG must be included.

GERMINATION Meeting Attendance: Travel funds must be included in the budget for (required) team attendance at annual GERMINATION grantees' meetings.

C. Due Dates

- **Letter of Intent Due Date(s)** *(required)* (due by 5 p.m. submitter's local time):

    August 27, 2021

    > For proposals that will be submitted to the GERMINATION Expansion track, LOI submission through FastLane is required. For proposals that will be submitted to the GERMINATION Innovation track, a research concept outline must be submitted by Email.

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

    October 29, 2021

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 other underrepresented groups 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

- **Potential for Success, Sustainability and Scaling:** How achievable and significant is the proposed framework, platform or environment? What are the prospects for sustaining this beyond the lifetime of the GERMINATION award? For GERMINATION Innovation proposals, how likely are the proposed approach(es) to be scalable and adaptable beyond the institution(s) involved in this initial study? For GERMINATION Expansion proposals, does the plan encompass a robust mechanism for scaling beyond a single institution?

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 Internal NSF Review.

GERMINATION Innovation proposals may be reviewed internally by NSF staff, reviewed in a panel or by ad hoc reviewers or any combination of these methods. **GERMINATION Expansion** proposals will be reviewed by panel and/or ad hoc reviews.

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.

Special Award Conditions:

PIs must include travel funds in the budget for (required) team attendance at annual GERMINATION grantees' meetings. Awardees will be required to attend and present their research plans and results annually at a GERMINATION grantees' conference for the duration of their award.

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:

- Louise R. Howe, Program Director, telephone: (703) 292-2548, email: lhowe@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.

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**   (703) 292-5111
>   (NSF Information Center)**:**
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> - **TDD (for the hearing-impaired):**   (703) 292-5090
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>   or telephone: (703) 292-8134
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> - **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:

Suzanne H. Plimpton
Reports Clearance Officer
Policy Office, Division of Institution and Award Support
Office of Budget, Finance, and Award Management
National Science Foundation
Alexandria, VA 22314

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