

# Molecular Foundations for Biotechnology (MFB)

## Partnerships to Transform Emerging Industries

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### PROGRAM SOLICITATION

#### NSF 22-554

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### REPLACES DOCUMENT(S):

#### NSF 21-540

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#### National Science Foundation

Directorate for Mathematical and Physical Sciences  
Division of Chemistry  
Division of Physics  
Division of Mathematical Sciences

Directorate for Computer and Information Science and Engineering  
Division of Information and Intelligent Systems

Directorate for Biological Sciences  
Division of Molecular and Cellular Biosciences

Directorate for Engineering  
Division of Chemical, Bioengineering, Environmental and Transport Systems

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

February 28, 2022

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

April 14, 2022

### IMPORTANT INFORMATION AND REVISION NOTES

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- The Directorates for Computer and Information Science and Engineering (CISE), Biological Sciences (BIO) and Engineering (ENG) are now participating in this solicitation.
- Research topic areas have changed.
- Eligibility criteria for who may submit proposals has been revised.
- Content requirements for Letters of Intent (LOIs) have been revised.
- Additional solicitation specific review criteria are included.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) ([NSF 22-1](#)), which is effective for proposals submitted, or due, on or after October 4, 2021.

### SUMMARY OF PROGRAM REQUIREMENTS

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#### General Information

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##### Program Title:

Molecular Foundations for Biotechnology (MFB)  
Partnerships to Transform Emerging Industries

##### Synopsis of Program:

This initiative calls for fundamentally new approaches in molecular sciences to drive new directions in biotechnology, a critical and emerging technology of the 21st century. This is the second year of a campaign targeting broad annual themes to be pursued through collaborative high risk/high reward projects.

This year's solicitation calls for synergistic scientific research collaborations that involve innovative machine learning (ML) methods to foster advances in research on the function of biomolecular systems and have the potential to drive innovation in biotechnology.

## 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.

- Catalina Achim, Division of Chemistry, MPS Directorate, telephone: (703) 292-2048, email: [mfb@nsf.gov](mailto:mfb@nsf.gov)
- Krastan B. Blagoev, Division of Physics, MPS Directorate, telephone: (703) 292-4666, email: [mfb@nsf.gov](mailto:mfb@nsf.gov)
- Zhilan J. Feng, Division of Mathematical Sciences, MPS Directorate, telephone: (703) 292-7523, email: [mfb@nsf.gov](mailto:mfb@nsf.gov)
- Wilson A. Francisco, Division of Molecular and Cellular Biosciences, BIO Directorate, telephone: (703) 292-7856, email: [mfb@nsf.gov](mailto:mfb@nsf.gov)
- Tingyu Li, Division of Chemistry, MPS Directorate, telephone: (703) 292-4949, email: [mfb@nsf.gov](mailto:mfb@nsf.gov)
- Marcia E. Newcomer, Division of Molecular and Cellular Biosciences, BIO Directorate, telephone: (703) 292-4778, email: [mfb@nsf.gov](mailto:mfb@nsf.gov)
- Steven W. Peretti, Division of Division of Chemical, Bioengineering, Environmental and Transport Systems, ENG Directorate, telephone: (703) 292-7029, email: [mfb@nsf.gov](mailto:mfb@nsf.gov)
- Amarda Shehu, Division of Information and Intelligent Systems, ENG Directorate, telephone: (703) 292-8191, email: [mfb@nsf.gov](mailto:mfb@nsf.gov)

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

- 47.041 --- Engineering
- 47.049 --- Mathematical and Physical Sciences
- 47.070 --- Computer and Information Science and Engineering
- 47.074 --- Biological Sciences

## Award Information

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**Anticipated Type of Award:** Standard Grant or Continuing Grant

**Estimated Number of Awards:** 6

The number of awards depends on the availability of funds and the quality of the proposals.

**Anticipated Funding Amount:** \$9,000,000

Contingent on availability of funds.

## Eligibility Information

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### 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: 1

An individual may be designated as senior personnel (which includes but is not limited to PI or co-PI) on at most one letter of intent, and at most one full proposal to this solicitation. In the event that an individual exceeds this limit, letters of intent and proposals will be accepted based on earliest date and time of submission, i.e., the first compliant letter of intent or full proposal will be accepted, and the remainder will be returned without review.

There are no eligibility restrictions on unfunded collaborators.

## Proposal Preparation and Submission Instructions

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### A. Proposal Preparation Instructions

- **Letters of Intent:** Submission of Letters of Intent is required. 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](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](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](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:**

Not Applicable

### C. Due Dates

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

February 28, 2022

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

April 14, 2022

## Proposal Review Information Criteria

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### 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

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### 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

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Machine learning (ML) can tremendously accelerate scientific progress and potentially transform the nature of research in the physical and life sciences. For example, the prediction of the structure(s) of a protein based on its sequence, a problem in biology that drew the efforts of physical and life scientists for several decades, underwent a transformative change in the last few years because of increasingly powerful and sophisticated ML methods. Novel, domain-situated ML and Artificial Intelligence (AI) approaches have the potential to advance our characterization and understanding of many biological macromolecules. The societal

consequences of such discoveries could be far reaching, as proteins and other biological macromolecules govern almost all life processes and have applications in biotechnology, medicine and industry.

This solicitation seeks to catalyze synergistic and innovative work at the interface of ML/AI on one hand and the biological, physical, and mathematical sciences and engineering on the other hand that goes beyond sequence-structure relationships and addresses standing challenges in biology. The funded research should have potential implications for biotechnology.

## II. PROGRAM DESCRIPTION

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The solicitation calls for synergistic, interdisciplinary research endeavors that:

1. bring together computer science expertise in ML/AI on one side and chemistry, biology, physics, engineering, and/or mathematics on the other side,
2. focus on integrated, convergent research projects that create new mechanism-guided machine learning frameworks for the prediction and detailed characterization of the function of biological macromolecules (e.g., protein, nucleic acids, and macromolecular assemblies of both protein and nucleic acids),
3. test the validity, specificity, and generalizability of the proposed ML frameworks with robust experimental platforms

The novel, interdisciplinary approaches considered by this solicitation could focus on current challenges such as:

- a. predict and characterize the interactions of intrinsically disordered proteins (or proteins that contain disordered regions)
- b. expand our understanding of the dynamic relationship between biopolymer function and the environment
- c. gain insight in the assembly of biomolecules into higher order complexes, including understanding, building upon, and/or disrupting protein-protein interactions
- d. design, synthesize, and characterize natural and synthetic polymer hybrids
- e. predict RNA (structure and) function

Projects that would be supported normally through regular, core programs of the participating NSF Directorates and Offices will not be considered responsive to the solicitation. For example, "traditional" computational biology/MD and protein evolution methods or those that apply well-established machine learning techniques to biological data are not of interest for this Solicitation. The solicitation also focuses on science-driven topics; efforts focused mainly on building database or infrastructure to support research efforts in the areas listed in this solicitation would not be of interest.

The research teams that implement the research plan also provide rich opportunities for professional training of mentees and workforce development. University-based opportunities can be augmented with opportunities for internships or similar opportunities for students and postdoctoral researchers to work in non-academic settings for up to three months per year.

If any collaborators affiliated with for-profit organizations are involved in the proposed project, collaborators should agree in advance how intellectual property (IP) rights will be handled. A signed agreement on IP, addressing both publication and patent rights, must be submitted to NSF prior to the issuance of an award. NSF will review this agreement to ensure that the graduation of students will not be unduly affected. NSF is not responsible for the agreement reached nor the IP information exchanged between collaborators.

There is no maximum or minimum number of collaborators. Proposers are invited to construct their teams consistent with the goals of the project and the resources available. The proposal should make a compelling case for the collaborative research project and the collaborative team. Collaborations involving more than one funded organization may use either method for submission of collaborative proposals described in PAPPG Chapter II.D.3, i.e., single proposal with subawards, or simultaneous submission of proposals from different organizations.

## III. AWARD INFORMATION

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**Anticipated Type of Award:** Continuing Grant or Standard Grant

**Estimated Number of Awards:** 6

The number of awards depends on the availability of funds and the quality of the proposals.

**Anticipated Funding Amount:** \$9,000,000

Contingent on availability of funds.

## IV. ELIGIBILITY INFORMATION

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**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: 1**

An individual may be designated as senior personnel (which includes but is not limited to PI or co-PI) on at most one letter of intent, and at most one full proposal to this solicitation. In the event that an individual exceeds this limit, letters of intent and proposals will be accepted based on earliest date and time of submission, i.e., the first compliant letter of intent or full proposal will be accepted, and the remainder will be returned without review.

There are no eligibility restrictions on unfunded collaborators.

**V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS**

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**A. Proposal Preparation Instructions**

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**Letters of Intent (required):**

Letters of Intent are required and must be submitted via FastLane or Research.gov even if full proposals will be submitted via Grants.gov.

The submission of a Letter of Intent by February 28, 2022, is required. Full proposals that do not correspond to a timely submitted Letter of Intent will be returned without review.

Required components of the Letter of Intent are given below. Letters of Intent that are not compliant with this solicitation will disqualify the PIs from submitting a full Proposal.

The Letter of Intent should include this information:

1. Project Title

Proposal titles must indicate the MFB program, followed by a colon, then the title of the project. Titles of collaborative proposals arranged as separate submissions from multiple organizations should begin with "Collaborative Research: MFB:" followed by the title of the project. The title should describe the project in concise, informative language that is understandable to a technically-literate reader.

2. Project Information

i) Synopsis (2500 characters)

The Synopsis should include a statement on the intellectual merit of the proposed activity and a statement on the broader impacts of the proposed activity. Include the specific goals of the research and testable hypotheses for each goal.

ii) Other Comments (2500 characters)

Explain how the project will address each of the four Additional Solicitation Specific Criteria identified in the Solicitation.

3. Optional Data Fields

i) Research disciplines (255 characters)

Identify the disciplines in which the research is grounded

ii) Key references (255 characters)

DOI and/or ISBN for key references cited in the Letter of Intent

4) List Senior Project Personnel and Participating Organizations

**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 4 Other Participating Organizations are permitted
- Additional Solicitation Specific Criteria is required when submitting Letters of Intent
- Key References is required when submitting Letters of Intent
- Submission of multiple Letters of Intent is not permitted

**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](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg). 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](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](mailto: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](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](mailto: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 or Research.gov. 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.

**The following information supplements the guidelines and requirements in the NSF PAPPG:**

**Proposal Titles:** Proposal titles must indicate the MFB program, followed by a colon, then the title of the project. For example, an MFB proposal title would be **MFB: Title**. Titles of collaborative proposals arranged as separate submissions from multiple organizations should begin with "Collaborative Research: MFB:" followed by the title of the project. For example, the title of each proposal for a collaborative set of proposals would be **Collaborative Research: MFB: Title**.

**Project Description:**

Describe the proposed project activities in up to 15 pages. The Project Description must include the following **subsections**, specifically labeled as below. **Proposals that fail to include one or more of these sections will be returned without review, without exception.**

- **Research Description:** A list of all participating PIs/coPIs, senior personnel and collaborators should be included on the first page. The Research Description section must describe the rationale and approach of the MFB research project. It should describe the challenges that drive the interdisciplinary research, hypotheses, and methods to test the hypotheses. It should identify major tasks, the primary researcher and organization responsible for each task, and anticipated key goals or milestones. Plans to ensure the reproducibility and replicability in sample and data collection, experimental design and methodology, and data analysis that align with community best practices must be included.
- **Research Team:** This section should summarize how the complementary expertise of the members of the project team is needed and appropriate to achieve the goals of the interdisciplinary research project and what are the contribution(s) of each collaborator will be. It should also include a management plan that identifies organizational responsibilities and approaches for communication and for meeting project goals.
- **Broader Impacts:** This section must address how the research could lead to generalizable concepts that can be applied to systems beyond those directly addressed in the proposal. It should also discuss the potential impact on future biotechnology, the education and training opportunities available through the project, and any other broader impacts.

## B. Budgetary Information

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**Cost Sharing:**

Inclusion of voluntary committed cost sharing is prohibited.

## C. Due Dates

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- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. submitter's local time):  
February 28, 2022
- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):  
April 14, 2022

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

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**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](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](mailto:fastlane@nsf.gov) or

[rgov@nsf.gov](mailto: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](mailto: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

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Proposals received by NSF are assigned to the appropriate NSF program for acknowledgment 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/](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

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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

In addition to the standard NSF review criteria described above, proposals submitted in response to this solicitation will be assessed on how strongly they meet the following criteria:

- How the proposed ML methods will be validated by planned experiments
- The potential of the new prediction methods to be applied or generalizable to systems beyond the specific biomolecules/biopolymers on which the project focuses
- The use of interdisciplinary approaches that develop new knowledge in both computer science and in biological, physical, and/or mathematical sciences
- Need for the proposed interdisciplinary collaboration to meet the goals of the proposed project and plans that enable synergy and effectiveness of the proposed collaboration

## B. Review and Selection Process

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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.

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## VII. AWARD ADMINISTRATION INFORMATION

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### A. Notification of the Award

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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

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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](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](mailto: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](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg).

#### Special Award Conditions:

If any for-profit partners are involved in the proposed project, all partners should agree in advance how intellectual property (IP) rights will be handled. A signed partnership agreement on IP, addressing both publication and patent rights, must be submitted to NSF prior to the issuance of an award. NSF will review this agreement to ensure that the graduation of students will not be unduly affected. NSF is not responsible for the agreement reached nor the IP information exchanged between partners.

### C. Reporting Requirements

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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](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg).

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## VIII. AGENCY CONTACTS

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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:

- Catalina Achim, Division of Chemistry, MPS Directorate, telephone: (703) 292-2048, email: [mfb@nsf.gov](mailto:mfb@nsf.gov)
- Krastan B. Blagoev, Division of Physics, MPS Directorate, telephone: (703) 292-4666, email: [mfb@nsf.gov](mailto:mfb@nsf.gov)
- Zhilan J. Feng, Division of Mathematical Sciences, MPS Directorate, telephone: (703) 292-7523, email: [mfb@nsf.gov](mailto:mfb@nsf.gov)
- Wilson A. Francisco, Division of Molecular and Cellular Biosciences, BIO Directorate, telephone: (703) 292-7856, email: [mfb@nsf.gov](mailto:mfb@nsf.gov)
- Tingyu Li, Division of Chemistry, MPS Directorate, telephone: (703) 292-4949, email: [mfb@nsf.gov](mailto:mfb@nsf.gov)
- Marcia E. Newcomer, Division of Molecular and Cellular Biosciences, BIO Directorate, telephone: (703) 292-4778, email: [mfb@nsf.gov](mailto:mfb@nsf.gov)
- Steven W. Peretti, Division of Division of Chemical, Bioengineering, Environmental and Transport Systems, ENG Directorate, telephone: (703) 292-7029, email: [mfb@nsf.gov](mailto:mfb@nsf.gov)
- Amarda Shehu, Division of Information and Intelligent Systems, ENG Directorate, telephone: (703) 292-8191, email: [mfb@nsf.gov](mailto:mfb@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](mailto:fastlane@nsf.gov)
- Research.gov Help Desk e-mail: [rgov@nsf.gov](mailto: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](mailto: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 (FASSED)* 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](mailto: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:

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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