



Smart Health and Biomedical Research in the Era of Artificial Intelligence and Advanced Data Science (SCH) NSF 21-530

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National Institutes of Health

Webinar

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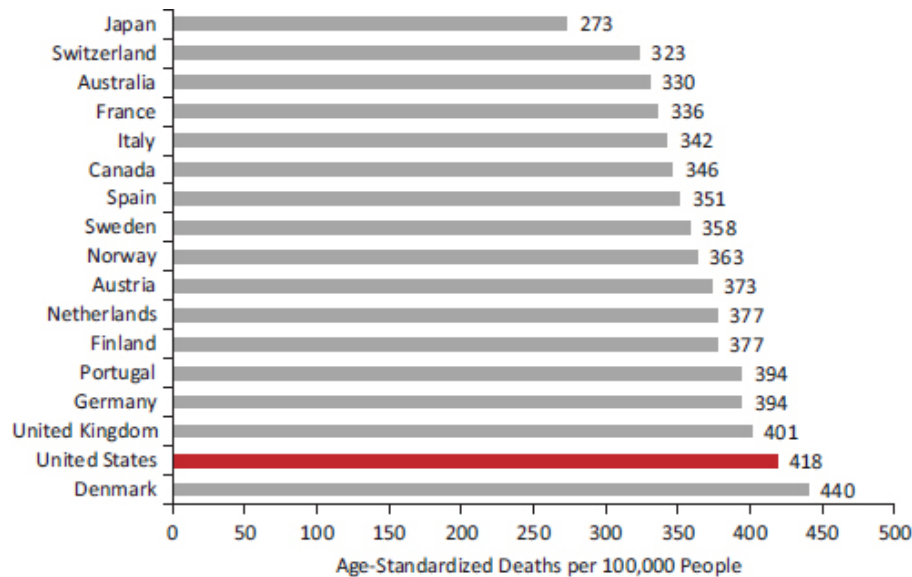
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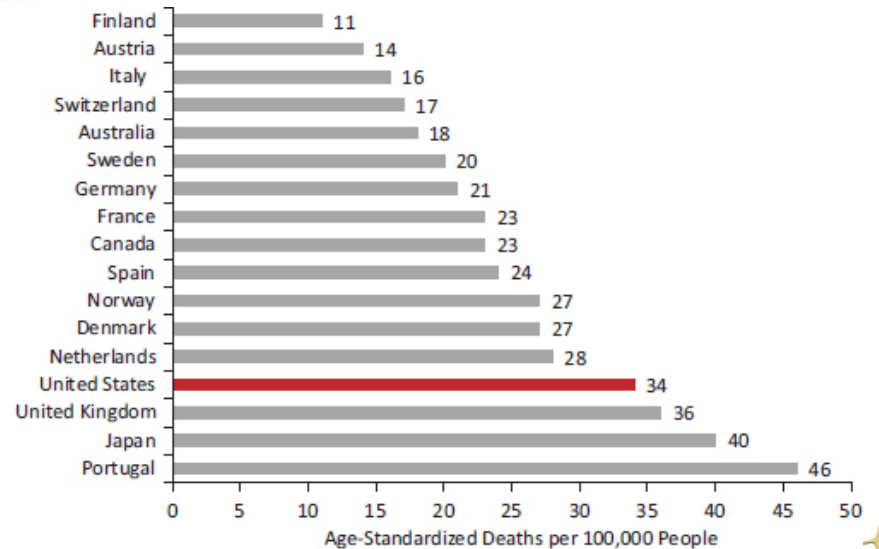
<https://grants.nih.gov/grants/guide/notice-files/NOT-OD-21-011.html>

U.S. Health: Shorter Lives, Poorer Health

Mortality from Non-Communicable Disease



Mortality from Communicable Disease



U.S. Children's Health Disadvantage

Children in the **US** have the **highest probability of dying before age 5** than any of the peer countries.

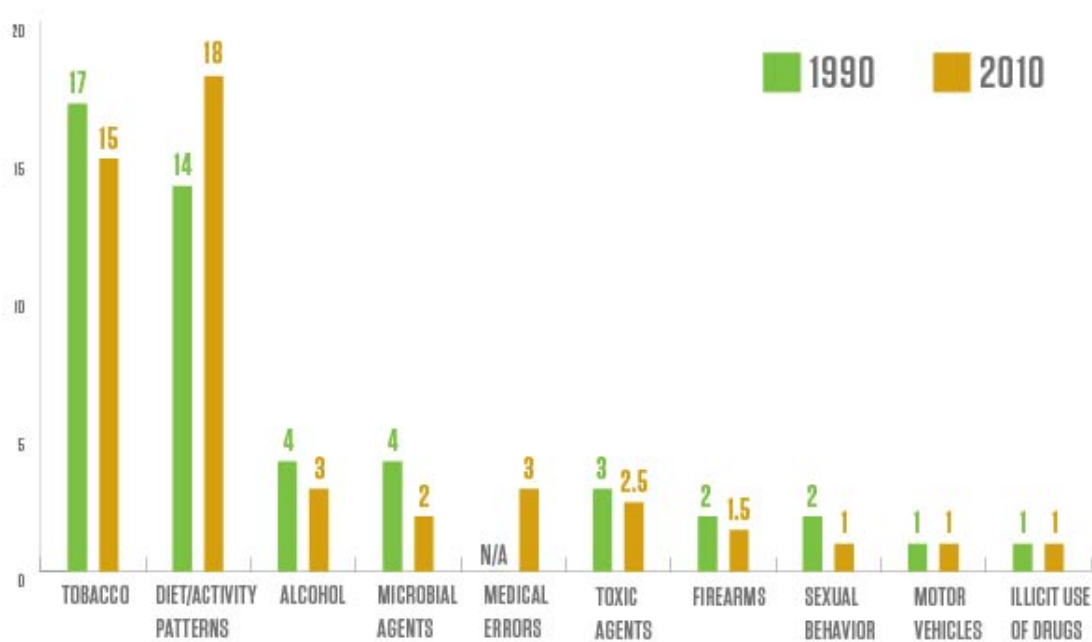


- ❑ Children in the **US** have the **highest probability of dying before age 5** than any of the OECD peer country
- ❑ In 2004, 11% of US deaths before age 5 were from injuries
- ❑ In 2006, the US had the highest death rates due to negligence, maltreatment or physical assault.
- ❑ The violent death rate of US boys age 1-4 has exceeded the OECD average since the late 1960s.
- ❑ The US is ranked 24th of 30 (OECD) and 21 of 21 (UNICEF) on selected measures of children's well-being.

Half of Premature Deaths are Preventable

Poor Diet, Lack of Exercise Impede Progress on Reducing Early Deaths.

PERCENT OF EARLY DEATHS (BEFORE AGE 80) BY CAUSE, 1990 AND 2010



NOTE: Deaths due to medical errors not calculated in 1990.

SOURCE: J. Michael McGinnis, "Actual Causes of Death, 1990-2010," Workshop on Determinants of Premature Mortality, Sept. 18, 2013, National Research Council, Washington, D.C.



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Smart Health and Biomedical Research in the Era of Artificial Intelligence and Advanced Data Science

A cross-cutting program supported by NSF and NIH
Proposals due to NSF on February 16, 2021 at 5:00pm

The program funds:

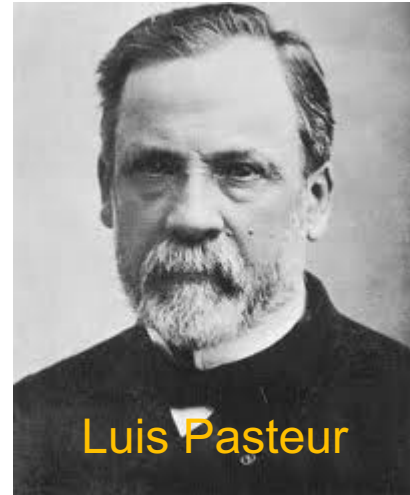
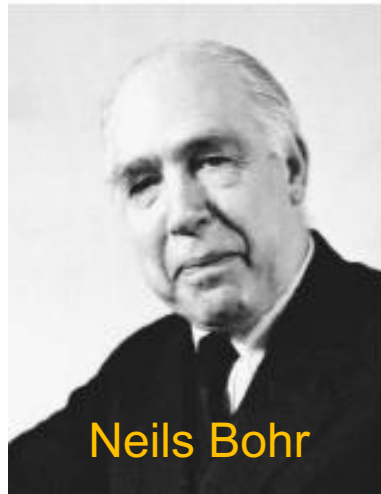
- Integrative Projects
- $\leq \$1,200,000$ total cost, up to 4 years
- Interdisciplinary teams
- Contribution to fundamental science from at least two NSF sciences

SCH is a case of use-inspired basic research



Pasteur's Quadrant

Quest for Basic Understanding



Low

High

Application Inspired: Consideration of Use

What is the goal of Smart Health?

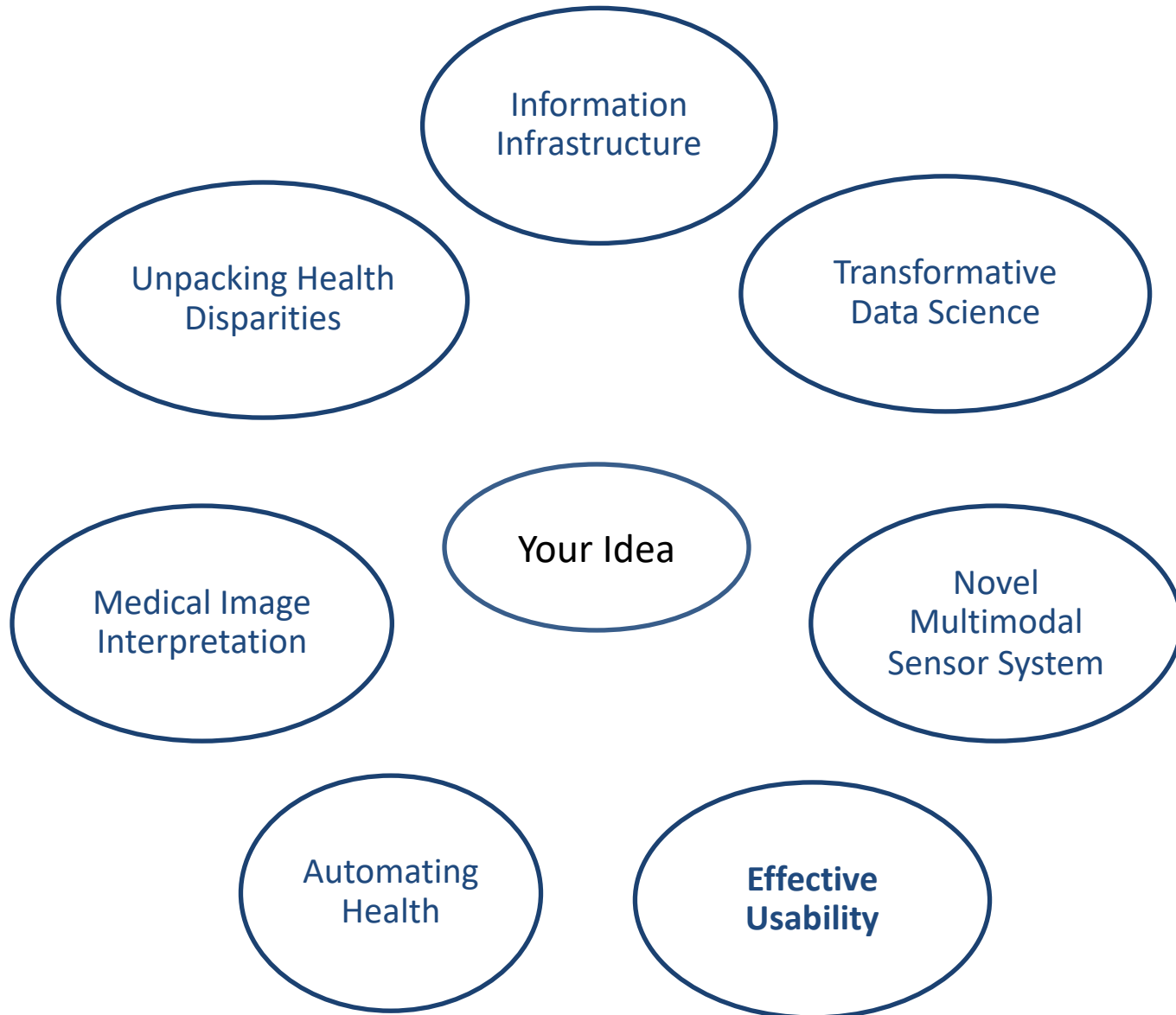
To support research and development of transformative high-risk, high-reward advances in computer and information science, engineering, mathematics, statistics, behavioral and/or cognitive science to address pressing questions in the biomedical and public health communities.

- **Proposals must include & address:**

- ✓ Research gaps that exist in science & engineering
- ✓ A key health/biomedical problem
- ✓ Include a team with appropriate research expertise in the major areas involved in the work

- Activities should **complement** rather than duplicate core programs of NSF & NIH as well as those of other agencies (e.g., VA and AHRQ)

Smart Health Research Thrusts



Information Infrastructure

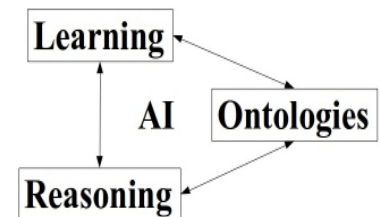
Scalable and Interoperable Systems

- Scalable digital infrastructure, languages, and tools
- Syntactic and semantic interoperability
- Findable, Accessible, Interoperable, Reusable (FAIR) sharing and use of data



Enhanced knowledge Representation

- Novel ontological systems and knowledge representation approaches



Ensuring high confidence security, privacy

- Methods for controlling and maintaining data integrity, provenance, security, privacy
- Providing trustworthy patient identification and authentication and access control protocols, while maintaining sensitivity to the legal, financial, cultural and ethical issues



Transformative Data Science

Fusion and Analysis

- Novel computational approaches for fusion and analysis of multi-level and multi-scale clinical, imaging, biomedical, personal, behavioral, social, contextual, environmental, and organizational data



Visualization and Modeling

- Robust knowledge representations, visualizations, reasoning algorithms, optimization, modeling and inference methods to support development of innovative predictive models



Visual, Behavioral Contextual & Multimodal data

- Computational models using non-traditional data
- Personalized models that focus on the context of health
- Longitudinal models focusing on human behavior and health



Novel Multimodal Sensor System

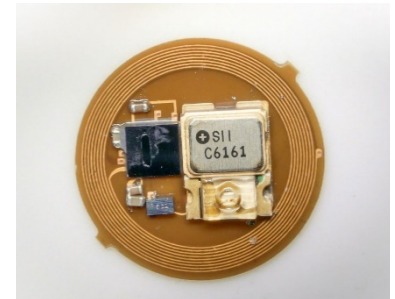
Sensor Systems

- Integrated sensor systems developed through innovative research on novel functional materials, devices and circuits for sensing or active interrogation of system states, imaging and communications



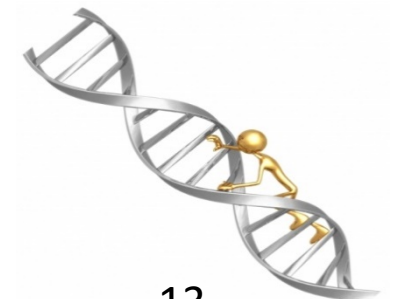
Multimodal Approach

- Just-in-time implantable, wearable, or mobile monitoring of biomarkers through various transduction mechanisms:
 - Electrochemical, Biochemical, Magnetic
 - Mechanical, Optical, Acoustic, Electrical



Personalized Models

- Use of sensor data to inform the development of innovative AI, machine learning, mathematical and statistical approaches to build predictive models for learning and decision making.



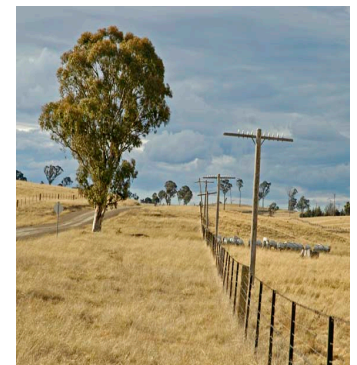
Effective Usability

**User- and
Context-
Tailored**

- New user- and context-tailored approaches to support individuals to effectively participate in their own health, while reducing user burden and increasing autonomy

**Diverse
Users**

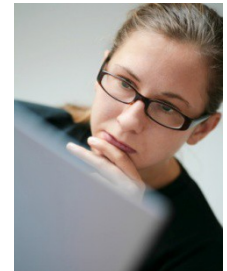
- Effectively support users across socio-economic status, digital and health literacy, technology and broadband access, geography, gender, and ethnicity



Automating Health

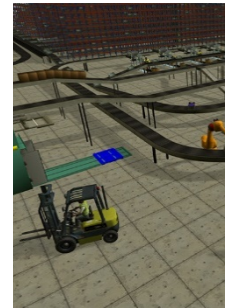
Closed-Loop

- Research that enables interoperable, temporally synchronized, devices and systems to connect data and devices and create closed-loop or human-in-the-loop systems



Modeling and Simulation

- Development of novel simulation and modeling that aid in the design and evaluation of new tools.
- New methods for enhancing digital clinical trials.



Generalizable platforms

- Development of technology platforms which can be utilized across a range of settings (e.g., home, primary care, schools, criminal justice system, etc.)



Medical Image Interpretation

Image Presentation

- Develop knowledge on how human pattern recognition, visual search, perceptual learning, attentional biases, etc. can be used to improve presentation modalities and identify the sources of inter- and intra-observer variability



Context and Environment

- Generate new models of how non-visual contextual information or environmental variations impact the perception of complex images



Exploiting Implicit knowledge

- New methods to exploit experts' implicit knowledge to improve perceptual decision making
- Research on optimal methods for conveying 3D (and 4D) information



Unpacking Health Disparities

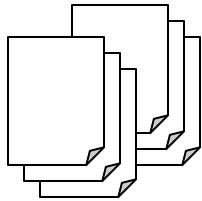
Reduce, Assess and Mitigate

- Develop holistic, data-driven or mathematical models to address the structural and/or social determinants of health.
- Proposers can also develop novel and effective strategies to measure, reduce and mitigate the effects of racism, explicit and implicit bias and their impacts on health outcomes.
- Computational approaches with social and behavioral models to better understand culture, context and person-centered solutions with diverse communities.
- Development of novel methods of distinguishing the complex pathways between and/or among levels of influence and domains.



Review Process

NSF
proposals



NSF/NIH
joint review
panels



Reviewers
NSF PDs
NIH SROs

reviews, ratings,
summaries,
qualitative
recommendations

reviews,
summaries,
quantitative
scores

**For proposals that NIH would like to fund, PIs
will be asked to submit them (without any
changes to the project description) in the NIH
format**

Interagency funding
meeting

NSF award
recommendations

*missions and
priorities*

NIH award
recommendations

NSF Merit Review Elements: Intellectual Merit and Broader Impacts

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?

Consider in top-down order.

Apply to broader impact activities as well as research.



What are Broader Impacts?

- Implicit (new knowledge, field, benefits to society ...)
- Explicit (technology transfer, results dissemination ...)
- Integration of Research and Education
 - Development of curriculum and supporting materials
 - Student involvement in emerging research and technology
 - Postdoctoral training (plan required if the proposal requests funding for one or more postdocs)
 - Data management (plan required)
- Broadening participation of underrepresented groups
 - Computer Science education, computer systems workforce
 - Gender, ethnicity, disability, geographic, etc.

CANNOT JUST BE THE BIOMEDICAL/HEALTH IMPACT

Smart Health Specific Review Criteria



Scientific
Requirement



Collaboration &
Management Plan



Evaluation Plan

Proposals advance two fundamental science/engineering areas:

- Computer and Information Science, e.g., artificial intelligence, machine learning, informatics, computer architecture, databases, natural language technology, networks, robotics, etc.
- Engineering, e.g., multimodal sensor technology, signal processing, optimization, operations research, closed loop systems, dynamic systems analysis, materials, etc.
- Mathematics and Statistics, e.g., stochastic modeling, analysis, interpretation and characterizing uncertainty, etc.
- Social, Behavioral and Cognitive Sciences, e.g., perception, social psychology, cognition, emotion, economics, ethics, linguistics etc.

Collaboration Plan

All proposals must include a Collaboration and Management Plan as supplementary document (no more than two pages)

The plan must describe:

- The description of the team and their roles.
- A plan for integration and ways to support interdisciplinary collaboration.
- The team member's expertise for the project.

Evaluation

All proposals must include an evaluation component

- Evaluation can target multiple areas:
 - Technical functioning,
 - Validity and reliability,
 - Usability; and,
 - Impact on biomedical/health outcomes
- Evaluations **SHOULD NOT** include randomized clinical trials

Final Comments

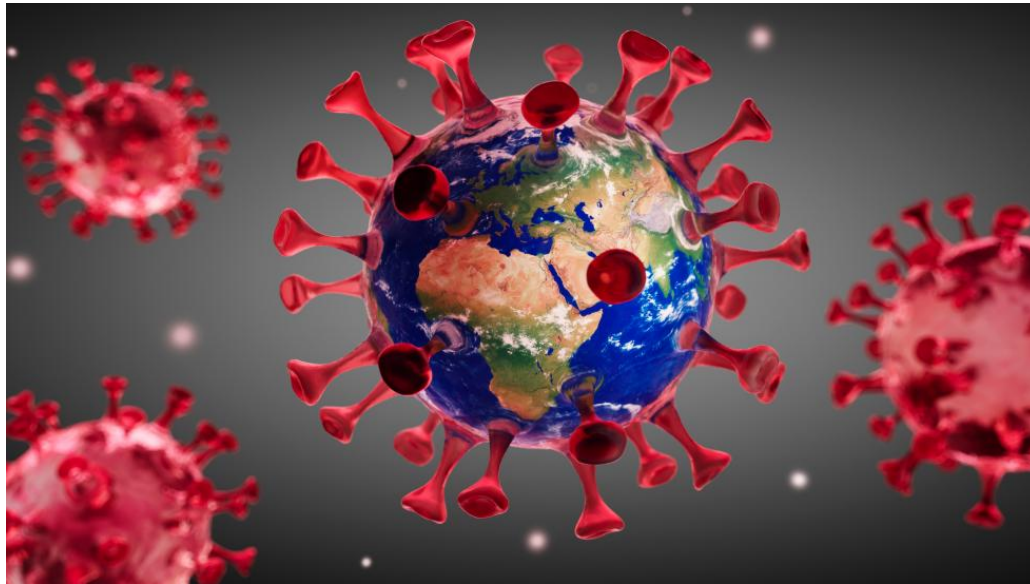


What proposals are not appropriate for this solicitation?

- Proposals should not:
 - Focus only on advancing biological, biomedical and/or public health research without new fundamental science or engineering.
 - Propose an application of existing fundamental science to the biomedical domain.
 - Focus on a topic that fits the mission of another agency.

What about COVID-19?

- As a major public health issue, COVID-19 is a health application that is within the Smart Health scope.
- Proposers should focus on the fundamental scientific and engineering contribution, but also consider whether a proposal will be timely for a four-year award.



Getting Feedback for your proposal

Send a one-page summary to NSF SCH-Correspondence@NSF.gov of your idea that briefly describes:

- **The Project**
- The **Intellectual Merit** (specific advances you expect to make in fundamental science/engineering)
- The **Broader Impacts** (health outcomes, outreach and education)

How does one apply?

- NSF:
<https://www.nsf.gov/pubs/2021/nsf21530/nsf21530.htm?org=NSF>
- NIH:
<https://grants.nih.gov/grants/guide/notice-files/NOT-OD-21-011.html>
- Refer to NSF “Proposal and Award Policies and Procedures Guide”
- Email: NSF SCH-Correspondence@NSF.gov

Join our Listserv

► SMARTHEALTH_COMMUNITY

Join the electronic mailing list (LISTSERV) for forthcoming announcements by — Sending an e-mail message to LISTSERV@LISTSERV.NSF.GOV from the mailing address at which you want to receive announcements.

The **body of the message** should read *Subscribe SMARTHEALTH_COMMUNITY [your full name]*.

The message is case sensitive; so capitalize as indicated!

- Don't include the brackets.
- The Subject line should be blank
- For example, for Robin Smith to subscribe, the message would read
- *Subscribe SMARTHEALTH_COMMUNITY Robin Smith.*

You will receive a confirmation of your subscription along with instructions on using the listserv.

Useful Website: www.nsf.gov



The screenshot shows the NSF website homepage. The header features the NSF logo and the tagline "National Science Foundation WHERE DISCOVERIES BEGIN". A search bar is located in the top right corner. The main navigation bar includes links for HOME, FUNDING, AWARDS, DISCOVERIES, NEWS, PUBLICATIONS, STATISTICS, ABOUT NSF, and FASTLANE. The AWARDS menu is highlighted, showing a list of links: About Awards, Managing Awards, Policies & Procedures, Award Conditions, Search Awards, Presidential & Honorary Awards, and Award Statistics (Budget Internet Info System). A red arrow points to the AWARDS menu. The main content area features a "SCIENCE NATION" section titled "Upping the Odds for Kidney Donation" with a "FULL STORY" button. The footer includes the text "Advancing the Sciences | Funding & Supporting | Inspiring & Educating" and a "HIDE" button.

NSF National Science Foundation
WHERE DISCOVERIES BEGIN

SEARCH

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Policies & Procedures
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SCIENCE NATION
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HIDE



**Effective
Research is a
relay
between
basic and
applied
science**

Thank you!

Questions or Comments?

Email:

SCH-Correspondence@NSF.gov