BioMADE

Request for Applications
Academic Challenge – BioMADE BUILD: Future Food

BUILD: Bioindustry for Undergraduate Interdisciplinary Learning & Discovery

February 2024

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ACADEMIC CHALLENGE
FUTURE FOOD

1. Introduction to BioMADE

BioMADE is a Manufacturing Innovation Institute (MII) sponsored by the U.S. Department of Defense (DoD) with a vision to build a sustainable, domestic, end-to-end bioindustrial manufacturing ecosystem. Our mission is to enable domestic bioindustrial manufacturing, develop technologies to enhance U.S. bioindustrial competitiveness, de-risk investment in relevant infrastructure, and expand the biomanufacturing workforce to realize the economic promise of industrial biotechnology. BioMADE is building a robust bioindustrial manufacturing ecosystem and has a national network of over 270 members spanning industry, academia, and non-profit organizations. BioMADE's primary aim is to accelerate the commercialization of new bioindustrial manufacturing technologies by guiding them through the pilot-scale Biomanufacturing Readiness Levels (BioMRLs) 4-7 (Smanski et al 2022). The direct outcome of these efforts will be to develop and expand industrial and defense-related biomanufacturing in the United States. BioMADE will drive advances by leveraging DoD funds and in-kind support from member organizations to complete projects critical to domestic bioindustrial manufacturing.

BioMADE has three core programs areas: Technology and Innovation (Tech), Education and Workforce Development (EWD), and Safety, Security, Sustainability, and Social Responsibility (4S). These three programs work together to advance innovation in the bioindustrial manufacturing ecosystem. The Tech program focuses on reducing key scale up and production barriers. The EWD program works with BioMADE members to promote greater diversity, equity, and inclusion within biomanufacturing careers. The 4S Program focuses on advancing and integrating the pillars of safety, security, sustainability, and social responsibility throughout its work. Successful proposals will demonstrate commitment and strategy for achieving a combination of programmatic goals in their implementation plan.

The U.S. requires a well-prepared workforce to meet the demand and realize the potential of bioindustrial manufacturing. Re-shoring of U.S. biomanufacturing capabilities at commercial production scale will need a talent pool of biomanufacturing professionals at all levels, from highly skilled technical workers, to bioprocessing engineers, pilot plant operators, Research and Development (R&D) scientists, and supply chain management. Developing a diverse and robust workforce to fuel the bioeconomy will require us to leverage what currently exists to support cross-disciplinary career pathways, recruit from non-traditional and underrepresented groups, and build a strong coordinated effort between a broad array of public and private entities.

2. The Academic Challenge Description: Future Food

BioMADE is pleased to announce the ***Academic Challenge: BioMADE Bioindustry for Undergraduate Interdisciplinary Learning & Discovery* (*BUILD) – Future Food,*** a national **Academic Challenge** competition for interdisciplinary, multi-collegiate teams and industry mentors based on the adoption and awareness of biomanufactured food and foodstuffs. These teams, hereafter, will be referred to as **BUILD Teams**.

The future food-focused theme includes target selection and design, feedstock optimization, bioprocess design and end-product formulation, and manufacturing processes, and is modeled based on real-world scenarios. This Academic Challenge places an emphasis on identifying target nutrients, exploring novel feedstocks, and developing manufacturing processes leading to the production of industrially biomanufactured food products with the potential for transformative societal impacts. This Academic Challenge provides undergraduate students with the opportunity to engage in practical research experience that promotes creativity, critical thinking, and technology innovation, while highlighting the critical need to develop bioindustrial manufacturing pathways leading to careers and employment skills.

The Academic Challenge focuses on providing better nutrition through bioindustrial manufacturing for food needs, both for the public and the private sector. Additionally, the Academic Challenge will focus on addressing critical technology bottlenecks in the bioindustrial production of food and foodstuffs. Multi-institute research teams will innovate around target nutrients, biomanufacturing technologies, and explore solutions to grand challenges for producing our future food supply. The Academic Challenge Scenarios offer opportunities to explore various scales of production. For practical purposes, the Academic Challenge will focus on table-top fermentation scale (2 L or less) for proof-of-concept, experimentation, and validation. In addition, nutritional needs are complex and can be dependent on audience age, gender, and physical activity level. This provides many opportunities for BUILD Teams to explore different aspects of a single scenario. BUILD Teams may elect to investigate the microbial production capability, nutritional needs of specific target audiences, potential production capacity of tabletop bioreactor units, input, resource, and feedstock requirements, etc.

The Academic Challenge will result in BUILD Team-based designs and solutions using applied research to solve problems related to food scarcity and production. This challenge is open to multi-institutional undergraduate student teams with a designated research-intensive university, and at least one additional Institute of Higher Education (IHE) to include two-year community and technical colleges, Minority Serving Institutions (MSIs), Historically Black Colleges and Universities (HBCUs), Hispanic Serving Institutions (HSIs), and/or Asian American and Native American Pacific Islander Serving Institutions (AANAPISIs). BUILD Teams will consist of college teams with two to four undergraduate students from each of participating IHE, with the final BUILD Team not to exceed 10 persons.

Addressing the Academic Challenge will require BUILD Teams that collectively represent an interdisciplinary academic background. Students will engage in practical hands-on experience with industrial biomanufacturing processes that include fermentation, bioreactor use, upstream and downstream processing. Students will have the opportunity to work with faculty and industry mentors to develop innovative approaches to provide better nutrition, access to food, stabilize nutritional supply chains, and address the environmental impact and social justice impacts of food produced using technologies in industrial biomanufacturing.

The Academic Challenge provides support for BUILD Teams to plan, investigate, and perform exploratory research to address critical challenges related to the production of food stuffs, macro and

micronutrients, and related topical areas that address one of four scenarios. These scenarios include future foods and production related to:

i. Rural and Urban Areas

ii. Humanitarian Assistance and Disaster Relief

iii. Austere Mobile Troops

iv. Long-Duration Military Base or Limited Space Environments

The Academic Challenge Scenarios will be described in more detail in *Section 6* of this document.

2.1 Academic Challenge Goals

- Drive adoption and awareness for biomanufactured food
- Expose a diverse group of students to career options and pathways in bioindustrial manufacturing through research and hands-on experiential learning
- Bolster interest in expanding bioindustrial manufacturing stakeholder networks, and academic programming at a variety of institutes of higher education
- Generate novel and innovative ideas that utilize bioindustrial manufacturing for food production to propose, test, and evaluate strategies to solve complex scenarios

2.2 Structure of the Academic Challenge

BUILD Team Applications

BUILD Team Applicants will prepare a project proposal concept paper to include: (i) Topic, (ii) Management Plan, (iii) Organizational Structure, (iv) Budget, (v) Deliverables, and (iv) Timelines. Guidance for the proposal, teaming, and logistics will be provided during Academic Challenge webinars in January 2024. Complete white paper proposals will be reviewed by the Advisory Committee and selected teams will advance to *Phase I* of the competition.

Team Concept Paper Submission Deadline: Friday, March 1, 2024.

PHASE I (April 2024-August 2024)

Ten BUILD Teams will be selected to advance to Phase I of the Academic Challenge and notifications provided by April 1, 2024. Phase I BUILD Teams can request up to $50,000 in support to cover expenses related to research, personnel expenses, student support, and other project-related expenses. Outcomes from Phase I will be due on August 15, 2024. Following review, three BUILD Teams will be selected to advance to Phase II of the Academic Challenge.

PHASE II (September 2024-January 2024)

Phase II will occur during the Fall 2024 academic semester and will provide selected teams the ability to perform additional proof in concept studies for feasibility, production scalability, application, and impact. Phase II will include additional industry support and advisement for project deliverables, to include possible manufacturing of product at the pilot scale. Phase II Team deliverables must include a tangible process or product related to bioindustrial manufacturing of food or food-related products. Each

BUILD Team advanced to Phase II can request up to an additional $50,000 in support to cover project-related expenses, to include project administration, supplies, reagents, and equipment.

3. Important Dates

- **February 12, 2024:** Academic Challenge Information and Templates available on the Website
- **March 1, 2024:** BUILD Team White Paper Proposals Due
- **April 1, 2024:** BUILD Teams Notified for Advancement to Phase I of the Academic Challenge
- **April 1, 2024 to August 15, 2024:** Phase I of the Academic Challenge
- **August 15, 2024:** Phase I Team Project Deliverables due (Presentations and Reporting)
- **September 2, 2024 to December 15, 2024:** Phase II of the Academic Challenge
- **December 15, 2024:** Phase II Team Project Deliverables due (Presentations and Reporting)
- **Week of January 13, 2025:** On-Site Meeting, BUILD Team Recognition, and Networking

4. Eligibility

- The application packet must be coordinated and submitted by a faculty member or administrative official at a research-intensive institution, which will also serve as the BUILD Team Lead.
- Eligible applicants include undergraduate students who are actively enrolled full-time in an academic program track in a two-year community and technical college or in a four-year IHE. This includes all accredited public and private colleges and universities, liberal arts colleges, Land Grant Universities, HBCUs, Tribal Colleges and Universities, and MSIs.
- Student participants must be identified as part of an intercollegiate BUILD Team. Undergraduate student participants must have an identified institute faculty mentor/sponsor from their institution. Several students from each institution may coordinate participation through a single faculty mentor for each college or university (see Academic Team Composition).
- All BUILD Academic Challenge participants must be 18 years or older, hold U.S. citizenship status, and be eligible to work in the United States.

5. Academic Team Composition

5.1 BUILD Team Structure

BUILD Teams will be composed of a maximum of 10 members, including faculty and student participants from all institutions. Team composition will include participants from one four-year research-intensive institutions and at least one community and technical college and/or MSI (HBCU, TCU, HSI, AANAPISI). Industry mentors will be required as part of the team, but will not be counted towards the 10-member cap.

The designated team lead must be a research-intensive university. The Lead will coordinate the BUILD Team student and faculty participants and serve as the primary point of contact and communication with BioMADE.

BioMADE will facilitate industry mentor involvement with the teams for guidance during Phase I and Phase II.

5.2 Interdisciplinary Undergraduate BUILD Teams

Undergraduates who are on a BUILD Team are encouraged to work across academic disciplines and may include students who are pursuing degrees related, but not limited to the following courses of study:

- Biochemistry
- Bioinformatics
- Biological Engineering
- Biotechnology
- Business Management
- Business
- Chemical Engineering
- Chemistry
- Computer Science
- Culinary Arts
- Economics
- Environmental Law
- Fermentation Science
- Food Science
- Industrial Engineering
- Marine Science
- Mechanical Engineering
- Microbiology
- Nutrition
- Systems Engineering

6. Academic Challenge Scenarios

In this Academic Challenge, BUILD Teams are expected to design a solution using tools in bioindustrial manufacturing to address a nutrition and food-related challenge based on the following scenarios:

SCENARIO 1: Rural and Urban Areas

Good nutrition is a problem in both rural and urban settings in the U.S. where people struggle to meet basic nutritional needs. A possible focus for the Academic Challenge is to select one of the existing macro and micronutrients that have been developed for biomanufacturing and design a simple, sturdy, inexpensive table-top fermenter capable of producing enough material to support a household (3-12 people) when added to other foods. Exploring acceptance of bioindustrial food production as a source for in-home nutritional food stuffs could be a potential area of investigation.

SCENARIO 2: Humanitarian Assistance and Disaster Relief

Meeting nutritional needs in disaster areas is a challenge due to the mixed age groups, and lack of resources (water, power, supplies). Looking at biomanufacturing of food products for 100 people in a disaster situation could include a point-of-need, portable system that would require low resource requirements. An important Academic Challenge option involves designing a sturdy and simple bioreactor that could generate enough material to meet nutritional requirements under extreme circumstances with limited resources.

SCENARIO 3: Austere Mobile Troops

Supporting mobile troops is an area of interest for the DoD. This scenario varies from other scenarios in that troops are highly active with specific caloric and nutritional requirements to maintain peak performance. Providing food stuffs with good storage capacity under severe conditions or considering how macro and micronutrients are added to other foods would be an interesting aspect. An additional aspect of this scenario could be the construction of modular and flexible Process Equipment Assemblies (PEAs) for processing different desired macro and micronutrients.

SCENARIO 4: Long-Duration Military Base or Limited Space Environment

While not part of the current set of capabilities required for military feeding, the future may hold the possibility of a biomanufacturing center, located, for example on a remote or isolated military base, submarine, or space station that can produce multiple biomanufactured food products; products that vary in food format (e.g., pudding, shake, bar, jerky, etc.) and in various desirable flavors and textures. Production of food and macro and micronutrients under closed-system or resource-limited environments would enhance our ability to thrive under difficult and challenging circumstances. The challenge presented here is to design and test a strategy to meet the need for food and nutrient production in a limited space environment.

6.1 Subtopics within Scenarios for Exploration

- Regulatory policy around bioindustrial manufactured foods
- Sturdiness and simplicity of fermentation systems
- Social acceptance of bioindustrial food products
- Shelf life/storage of products
- Availability and flexibility of feedstock
- Modular and flexible designPalatability of additives or food products
- Nutritional requirements across varying demographic populations
- Cost and process efficiencies for bioproduction

6.2 Technical Aspects to Explore for Each Academic Challenge Scenario

Focus Area	Actions	Examples
Target Selection and Design	Identify nutrients of interest, and appropriate structure for delivery.	Vitamins, Omega-3 oils (DHA & EPA), essential amino acids, proteins, fats, sugars, current biomanufactured foods that could be incorporated into the design.
Feedstock Optimization	Identify and explore local options, consider variability of materials, processes, and costs.	Waste from plant oil production, breweries, sugar refineries, bakeries, etc.
Bioprocess Design	Identify factors used to select the bioreactor form and function. Identify ideas and potentially test ways to increase production and efficiency.	Flexibility, cleaning, monitoring, recycling waste from process.
Finished Production Formulation & Manufacturing	Explore processing options and consider scale up challenges to create food stuffs. Consider including current biomanufactured ingredients or foods to promote adoption.	Yield, stability, flavor, texture, environmental impact, resource requirements, simplicity.

6.3 Examples of Potential BUILD Team Products from the Academic Challenge

- Biomanufactured food item ready for consumption through novel formulation or production methods
- Biomanufactured food ingredient with improved properties (e.g., higher shelf-life stability, better nutrient density). Note: proteins developed should include all essential amino acids in ratios similar to eggs or whey protein
- Design of a portable bioreactor for field use
- Identification of ubiquitous feedstocks (may include recapture and re-configuration to a usable form)
- Development of a portable, agile downstream processing system with possible applications towards food safety and/or final product development (e.g., flavor and texture)
- Food safety plan for the entire system
- Bioavailability studies on biomass
- Identification of cost saving measures for bioproduced food stuffs

7. White Paper Preparation and Submission

White Papers will be submitted electronically via the **BioMADE BUILD Academic Challenge: Future Food website**, using the template: Academic Challenge White Paper Template.docx

White Papers should include an executive summary; a work statement and a justification/impact statement; and a team management plan with key personnel. A project plan and timeline and budget justifications are not included in the five-page limit.

8. Budget and Justification

A budget is requested for both Phase I and II. Phase I is detailed; Phase II is high level, with detailed justification requested upon selection for advancement to Phase II. The budget request must include both direct and indirect expenses and not exceed $50,000 total for Phase I activity. We request a detailed budget and justification for all Phase I applicant Teams, and a high-level projected budget for Phase II, should the project be selected for advancement through the Academic Challenge for continued work. Phase II budget shall not exceed $50,000 total and, inclusive of both direct and indirect expenses. The budget must be accompanied by the budget expense justification. Templates for the Budget and Budget Justification will be provided through the Academic Challenge Website.

9. Intellectual Property (IP)

BioMADE requires Government Purpose Rights (GPR) on Academic Challenge submissions. The Advisory Committee does plan to retain entries after the Academic Challenge is completed in order to help shape future technology decisions. By submitting an application, BUILD Team members consent to the use of data submitted for use within Government Purposes only.

BioMADE cannot and will not make determinations on whether or not third-party technologies in the Academic Challenge submissions have protectable intellectual property (IP) interests. By participating in this Academic Challenge, each applicant (whether participating individually or as a team) warrants and assures BioMADE and the Government that any data used for the purpose of submitting an entry for this Academic Challenge, were obtained legally and through authorized access to such data. By entering the Academic Challenge and submitting the Academic Challenge materials, each BUILD Team member agrees to indemnify and hold BioMADE and the Government harmless against any claim, loss or risk of loss for patent or copyright infringement with respect to such third-party interests.

Any applicable ownership of IP in the application will remain with the BUILD Team members. By participating in the Academic Challenge, the applicant is not transferring any exclusive IP rights in applicable patents, pending patent applications, or copyrights in connection with the application. However, by submitting the application, each BUILD Team member agrees to grant BioMADE and the federal government certain license rights, as set forth in this section.

Specifically, each BUILD Team member grants BioMADE and the Government the right to review the submission, to publicly describe the submission in any materials created in connection with this challenge, to screen and evaluate the submission, and to have the Advisory Committee, the Academic Challenge administrators, and the designees of any of them review the submission. BioMADE and the Government is also granted the right to publicize Academic Challenge participant names and, as applicable, the names of BUILD team members and/or organizations that participated in the submission following the conclusion of the challenge.

10. Frequently Asked Questions (FAQ)

a. Can high school or graduate students participate in the Academic Challenge?

The BUILD Team members are limited to undergraduates and institutional mentors. Institutional mentors may include faculty and graduate students; importantly, the project development, ideation, and deployment is to be performed by undergraduate members of the BUILD Team. Graduate students who may wish to be involved are eligible to serve in a research Mentor capacity.

b. How will industry mentors be identified as part of the BUILD Teams?

BioMADE will facilitate industry mentors for the Phase I BUILD Teams, with a more substantive involvement with Industry in Phase II. Industry mentors will be matched to BUILD Teams based on subject matter areas.

c. Can BUILD Team Institutes apply indirect costs?

Phase I and Phase II budgets are capped at $50,000 per phase, with a total of $100,000 for teams who are advanced through Phase I and II. Budgets will be at the discretion of the primary institute. Expenses must comply to federal allowable costs and are subject to institutional requirements for indirect costs as identified.

d. What expenses can be covered in the requested budget?

Allowable expenses include time and effort for students, faculty/mentors, reagents, supplies, consumables, and non-capital equipment. Student support related to performance of the research activities is also supported.

e. Are BUILD Team travel expenses covered for participation in the Academic Challenge Finale in January 2025?

Yes, travel expenses for BUILD Teams representatives to attend the Academic Challenge Finale in January 2025 will be covered above and beyond the budget request for Phase I and Phase II.

f. Can the award amount be used to support student time and effort?

Yes.

g. Can the award amount be used to support faculty mentor time and effort?

Yes.

h. For BUILD Teams not advanced to Phase II, is there any support for continuing research efforts?

Continuing support for *Phase II* of the Academic Challenge is provided only for those teams that are selected to advance to *Phase II*.

i. Is there a cost share requirement for the BUILD Teams to participate in the Academic Challenge?

No. The Academic Challenge does not have a requirement for cost share.