Maine EPSCoR FY24-29 NSF EPSCoR RII Track-1
Proposal Development Process Phase I – Research Concept Papers

1) Proposed Research Focus:	**Maine Advanced Center for Marine Biotechnology**				
2) Primary Contact Person: José A. Fernández Robledo					
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3) Suggested/Potential Key Senior Personnel:					
Name:	**Institution:**	**Title:**	**Dept.**	**E-mail:**	**Phone:**

4) Intellectual Merit:

A. ***Need****: a brief statement of the research problem/need to be addressed and why it is urgent for Maine to address this problem/need now (how it is currently limiting the state's capacity/research competitiveness).*

Marine biotechnology provides a unique opportunity not only for harvesting the genetic treasures hidden in marine organisms but also to translate discoveries into business opportunities. In the last decade, an impressive amount of information using high-throughput omics technologies have been generated for marine species; however, the current understanding of how gene expression patterns are linked to various biological processes (*e.g.*, oyster shell formation, adaptation to global warming) and commercial traits (*e.g.*, fast-growing aquaculture species, production of food additives) is extremely limited because of the lack of information on gene function (genomes to phenome) and the ability to engineer the marine organisms that would interrogate genomes and generate robust commercial strains for aquaculture and bioreactors. To address these deficiencies, new tools for genome editing (*e.g.*, CRISPR/Cas9) represent an exciting opportunity for the analysis of biological potential. Most biotechnology hubs in the Northeast focus on biomedicine; here, we propose developing and training the workforce in state-of-the-art biotechnologies with an emphasis on marine organisms/systems. Maine offers a diverse biotechnology sector and benefits from its proximity to the Boston-Cambridge hub. This proximity provides the advantages of the latest technologies under development with a lifestyle that large hubs intrinsically lack. Maine is also home to several high-quality Liberal Art Colleges and Community Colleges. Another advantage of biotechnology hubs is that they do not necessarily require significant infrastructure, as most sophisticated new technologies are performed in small lab spaces. Finally, the nature of the project might also be of interest for other Maine research institutions, including MDIBL, UMaine, BioME, JAX, among others.

B. ***Research Goal & Objectives:*** *describe the overall project goal to address this problem/need and the related research objectives.*

Create the Maine Advanced Center for Marine Biotechnology (MACMB) for incorporating, developing, and making available the latest genetic/molecular technologies to species of interest to Maine, but also national and worldwide. The MACMB would be the reference for training undergraduate, graduate, and scientists to incorporate/explore biotechnology approaches to guide/support hypothesis-driven science and Maine's ingenuity that requires state-of-the-art molecular techniques for generating products of commercial interest. The MACMB would promote the advantages of bringing biotechnology to Maine and contribute to spin hypothesis-driven basic science into biotech incubators.

Research Actions: *describe a few specific key research actions that could be implemented to meet the objectives. Withhold any information deemed sensitive, given this form will be shared with the community.*

- Build an interdisciplinary network of labs with expertise in genetic engineering of marine species
- Developing genetic systems for species of interest (*e.g.*, American oyster and lobster, microalgae) for guiding selective breeding and for domesticating species of interest, and for producing commercial products
- Provide training opportunities for marine biotechnology
- Develop resources for cellular aquaculture
- Public outreach to educate the public on challenges on marine biotechnology
- Incorporate hands-on biotechnology training programs from sequencing and bioinformatics to genetic engineering for undergraduate and graduate education, community colleges, and liberal arts colleges.
- Participation of high-school students and undergraduates on iGEM, an international program for developing critical thinking and problem solving using genetic engineering
- Engage Maine legislators on both traditional and advanced technology aquaculture

C. ***Priority:*** *indicate how this research would address national priorities (*FY2022 budget request to Congress, White House 2021 R&D priorities memo*) and state priorities (*Maine Economic Development Strategy 2020-2029, 2017 Maine Innovation Economy Action Plan*).*

- Understanding the Rules of Life. In the post-genomic era, we need to focus on ways to interrogate genomes: Genome to Phenome. Resolving unknown gene functions would lead to discoveries, some of them having an immediate application or result in new technologies or products
- Biotechnology. It is predicted that some marine species will be more sensitive to the changing environment. Biotechnology provides a unique way of accelerating evolution for engineering resilient aquaculture strains and developing alternative biological chassis for the production of recombinant proteins and secondary metabolites
- Catalyze Research and Innovation in Critical and Emerging Technologies. Cellular aquaculture and engineering resilient aquaculture strains
- National Security and Economic Resilience. Securing traditional food sources and developing new protein sources. Cellular agriculture is a new industry that is gaining importance and popularity in response to a series of concerns that the modern consumer is demanding and technological and strategic for leading the next revolution in how to produce safe and reliable alternatives or complements to traditional food sources. Similarly, cellular aquaculture can play a similar role in culturing seafood and seafood derived products
- - Create a Hub of Excellence by providing supporting infrastructure, promoting innovation, growing local, and attracting new talent

5) Broader Impacts:

D. ***In-state collaborations****: describe the potential for collaborations within Maine (considering diverse participants from institutions of higher education, PUIs, and community colleges, as well as productive partnerships between Maine's academic institutions and governmental, non-profit, and commercial or industrial sectors).*

- BioME. Over the last decade, BioME has been playing an essential role by agglutinating the biotech companies and laboratories in Maine and developing outreach programs and meetings with Maine legislators
- Darling Marine Center and UMaine are the larger higher degree institutions in Maine with faculty with expertise and with experience, and room to host new faculty
- Maine Technological Institute is our hub for spin-offs; they can guide labs interested in moving discoveries to the market
- Mount Desert Island Biological Laboratory and The Jackson Laboratory are two well-known international institutions that can serve as a model for some of the resources to build
- Southern Maine Community College has been preparing students in biotechnology to serve the local

biotech companies
- Roux Institute at Northeastern University is a newcomer to Portland, and it is focusing on shaping tech talent and innovation through academic and entrepreneurial programs
- The Davis Institute for Artificial Intelligence (Colby College), of recent creation, the AI is called to accelerate the next leaps in science including biotech projects

E. ***Regional/national collaborations****: describe the potential for coalitions among regional and national EPSCoR jurisdiction-based organizations and/or partnerships with nationally recognized centers of R&D activity, such as federal and industrial R&D laboratories, NSF-sponsored research centers, and academic institutions with nationally recognized research capabilities.*

- Gloucester Marine Genomics Institute (GMGI). Focused on the genomics of marine species, they have participated in the sequence of the American lobster genome
- Northeastern University has developed a co-op for students to spend six months in a designated lab; this would provide an excellent opportunity to introduce and keep talent in Maine.
- The Center for Cellular Agriculture and Cultured Meat (CACM) (Tufts University). Of recent creation, the CACM is expanding beyond cultured meat and is exploring producing cultured seafood. Maine could be part of this novel adventure by focusing on marine species
- Ginkgo Bioworks is a biotech company that applies software and electric engineering principles to biology. MACMB would look to partner with them to apply the same synthetic biology approaches to marine species

F. ***Economic development****: describe the potential for economic growth in Maine.*

- Provide incubators and attract start-ups to Maine by providing a trained workforce
- Provide the scientific and cultural environment to retain the scientific workforce and avoid talent migration outside of the state
- Generating Intellectual Property (IP) by establishing procedures and commercializing products
- Provide a trained talent pool to attract companies to Maine

G. ***Workforce Development****: describe the potential for statewide workforce development in this research area (e.g., support for faculty and student teams that include women, minorities underrepresented in STEM, and persons with disabilities that will result in a robust and quantifiable impact on the STEM workforce; may also consider support for students who are in the first generation of the family to attend college or those from economically disadvantaged or rural populations).*

- Hire new faculty tailored to the MACMB
- Establish a graduate program on genetic engineering of aquacultured species
- Establish a masters program on biotechnology applied to marine species
- Apply genomics and genomic tools to prevent and solve the challenges of growing aquaculture
- Exposing students to the possibilities of genomics and genetic engineering and how to create new business opportunities derived from basic science
- Inspiring students to pursue careers in biotechnology
- Educating the general public on the potential of biotechnology
- Attracting, securing, and retaining existing scientists to Maine
- Create a web-based and itinerant exhibition for K-12

H. ***Infrastructure****: describe potential to provide infrastructure (e.g., physical and/or cyber) that grows the state's academic research and education capacity.*

- Build a state-of-the-art facility for delivering genes (*e.g.*, microinjection, electroporation) and analyzing genetic variants (*e.g.*, sequencing facility) of marine species
- Build a fully-contained facility to generate, maintain, and distribute engineered bivalves and lobsters
- Generate a web-based platform for method development for targeting individual and gene groups
- Maintain an office to inform and educate the public about genetic engineering and cellular aquaculture