Maine EPSCoR FY19-24 NSF EPSCoR RII Track-1
Proposal Development Process Phase I – Research Concept Papers

1) Proposed Research Focus:	Biotechnology				
2) Primary Contact Person:					
Name:	**Institution:**	**Title:**	**Dept.**	**E-mail:**	**Phone:**
Judy Stone	Colby College	Dr.	Biology	jstone@colby.edu	859-5736
3) Suggested/Potential Key Senior Personnel:					
Name:	**Institution:**	**Title:**	**Dept.**	**E-mail:**	**Phone:**
Dave Angelini	Colby College	Dr.	Biology	drangeli@colby.edu	859-5734
Russell Johnson	Colby College	Dr.	Biology	rrjohnso@colby.edu	859-5723
Julie Millard	Colby College	Dr.	Chemistry	jtmillar@colby.edu	859-5757
Kevin Rice	Colby College	Dr.	Chemistry	kprice@colby.edu	859-5763
Andrea Tilden	Colby College	Dr.	Biology	artilden@colby.edu	859-5743

4) Intellectual Merit: (the research focus)

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).*

The field of genomics is on the cutting edge of science, and it is rapidly changing the way we undertake biological, biomedical, and environmental research and technology. Maine already has a relative strength in this area, and additional investment has the potential to propel us to the forefront.

B. ***Research Goal & Objectives:*** *describe the overall project goal to address this problem/need, and 1-3 key research objectives.*

We aim to develop an integrated program that supports research, education and outreach in the field of genomics by leveraging and strengthening existing connections between the state university system, research institutions, and undergraduate colleges. Key research objectives include:

Developing and employing new technologies in next-generation sequencing and analytical pipelines

Developing tools to study processes such as genomic conflicts, duplicated gene function, or introgression

Developing techniques to more quickly and accurately describe microbiomes

Untangling the complex interplay of factors that connect genotypes with phenotypes

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

1. Obtain and analyze transcriptomic and genomic data from non-model systems that have innate advantages for addressing certain questions. Such non-model systems and questions include:
   - A species with polyphenism, or the production of distinct phenotypes under different developmental conditions, provides a valuable opportunity to study the role of gene expression in development.
   - An ancient duplication of a gene with well-known function can be used to explore the process of neofunctionalization in different lineages, whereby different gene copies take on slightly different roles.
   - A lineage that shows different histories for nuclear versus organelle genomes can be used to explore inter-genomic interactions.
2. Obtain and analyze genomic data from environmental samples having ecological implications.
3. Obtain genotypes of biomedical relevance from human subjects and look for correlations with phenotypes as well as biological indicators of outcomes.
4. Use comparative genomics to explore major evolutionary events such as eukaryogenesis, gene modularity, multicellularity, and genomic plasticity.
5. Engage in undergraduate education and outreach to disseminate all of the above findings.

D. Priority: *indicate how this research would address NSF and state priorities in advancing the frontiers of knowledge and understanding (within a field and/or across different fields).*

An investment in genomics research addresses two (of six) major NSF priorities: harnessing data for 21st century science and engineering, and understanding the rules of life. Genomics is identified as an area where Maine has developed "distinct knowledge and skills" within the targeted technology sector of biotechnology. In addition, development of expertise in genomics will naturally entail development of cyberinfrastructure and other capacities in information technology.

5) Broader Impacts: (related to the research focus)

E. ***Impacts****: potential to benefit society and contribute to the achievement of specific, desired societal outcomes.*

Findings of genomic research are on the cusp of transforming environmental and biomedical practice. For example, genomics of environmental samples are already replacing conventional assays for early indicators of outbreaks of harmful microorganisms. In medicine, genomic advances are paving the way for personalized medicine, with diagnoses and therapies targeted towards individual's genomes and towards specific cancers. Associated developments in analytical tools and cyberinfrastructure will broadly benefit society, as they will support more efficient and effective processing of all kinds of information.

F. ***Impacts****: potential economic development as a result of this research.*

Genomic research is already a mainstay of the Maine economy, with The Jackson Laboratory recognized worldwide for its innovations in this area. The Bigelow Laboratory for Ocean Sciences is also renowned as a center of genomics and has pioneered commercially viable genomic methods for testing water quality. A workforce well trained in genomics has the potential to create new businesses and nonprofits that employ these technologies to provide diagnostics to meet the need for marker-assisted breeding in agriculture, bioengineering in forest tree improvement, individual genomics for personalized medicine, or environmental assays.

G. ***Impacts****: potential for statewide workforce development in this research area (faculty, postdocs, graduate and undergraduate students, and the professional workforce).*

As genomics is a rapidly evolving field, an infusion of training will be necessary to propel Maine's workforce to the cutting edge. A research infrastructure network will provide peer mentoring and training opportunities for Maine's faculty, postdocs, and graduate students. Funding to undergraduate institutions will be necessary to train the next generation of researchers and practitioners. Outreach to the current workforce will also be essential. Colby College is already engaged in educational and outreach partnerships with the Bigelow Laboratory for Ocean Sciences and The Jackson Laboratory. A valuable extension of these efforts would be to extend training opportunities to medical professionals so that they can make use of emerging technologies in personalized medicine.

H. ***Impacts****: potential to provide infrastructure that grows the state's academic research and education capacity.*

An investment in genomics research will dramatically enhance the state's research and education capacity. Genomics infuses all areas of the biological sciences, and advanced training of educators will have lasting impact. In addition, the cyberinfrastructure improvements that necessarily accompany development of genomics capacity will have lasting impacts. For example, a recent cyberinfrastructure NSF grant to Colby, University of Maine at Orono, and The Jackson Laboratory provides network infrastructure to support computational biology, computational science, and computing capacity more widely across the curriculum.