Form B: IGEM-HERC Full Proposal Cover Sheet

Idaho State Board of Education

PROPOSAL NUMBER: (to be assigned by HERC)	TOTAL AMOUNT REQUESTED: **$92,700**
Proposal Track (select one): **Proof of Concept**	

TITLE OF PROPOSED PROJECT: **Developing Novel Fungicides for Sustainable Potato Production**

SPECIFIC PROJECT FOCUS: **We will identify novel protein targets for fungal disease and use modeling and experiments to discover chemical compounds that inhibit fungal growth. We will optimize promising compounds to increase their efficacy as fungicides and for use in the field.**

PROJECT START DATE: **07/01/2024** PROJECT **END DATE: 06/30/2025**

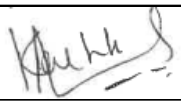
NAME OF INSTITUTION: **Regents of the University of Idaho** DEPARTMENT: **Physics (other departments listed in Appendix C)**

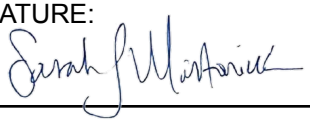
ADDRESS: **875 Perimeter Dr MS 0903, Moscow, ID 83844**

E-MAIL ADDRESS: **ytreberg@uidaho.edu** PHONE NUMBER: **208-874-3603**

	NAME:	TITLE:	SIGNATURE:
PROJECT DIRECTOR/PRINCIPAL INVESTIGATOR	**Marty Ytreberg**	**Professor**	
CO-PRINCIPAL INVESTIGATORS	**Brenda Schroeder**	**Associate Research Professor**	
	Paul Rowley	**Associate Professor**	
	David Condon	**Research Scientist II**	

NAME OF PARTNERING COMPANY: **Gowan Company LLC** COMPANY REPRESENTATIVE NAME: **Kartik Anand (Global Asset Manager – Fungicides)**

SIGNATURE: 

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE NAME: Sarah S. Martonick SIGNATURE: 

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Name of primary Idaho public institution: University of Idaho

Project Title: Developing Novel Fungicides for Sustainable Potato Production

Name and project-related credentials of Principal Investigator directing the project: Marty Ytreberg, Professor of Physics and Associate Director of Institute for Modeling Collaboration and Innovation, University of Idaho

Name and project related credentials of other key personnel (key project team members): Brenda Schroder, Associate Research Professor of Plant Pathology, University of Idaho; Paul Rowley, Associate Professor of Biology, University of Idaho; David Condon, Research Scientist II in Institute for Modeling Collaboration and Innovation, University of Idaho

Project objective(s) and total amount requested: We request $92,700 to achieve two objectives during the one-year funding period. For Objective 1, we will expand our list of potential protein targets that are unique to fungi, and determine potential inhibitors using molecular modeling. In Objective 2, we will synthesize predicted inhibitors, experimentally measure their ability to inhibit fungal growth and determine their potential for fungicide development. Detailed objectives are provided below.

Resource commitment: The full team (shown below in **Appendix C**) is committed to working together to ensure the completion of the project objectives.

Our proposed project aligns with two of the University of Idaho's strategic initiatives: (1) Supporting student success: We will involve undergraduate and graduate student researchers in our project. These students will learn to perform cutting-edge research in a multi-disciplinary team of scientists. (2) Prioritizing research: The proposed project is a grassroots research project developed by our team that capitalizes on our strengths and expertise and seeks to benefit the state of Idaho.

In addition, our proposed research aligns with the Idaho Higher Education Research Strategic Plan. It will establish a collaboration with an industry partner, it has the potential to lead to novel fungicides, and it involves a highly interdisciplinary research team. Our work aligns particularly well with "Objective 2.A: Create research and development opportunities between the institutions and the private sector", and "Objective 3.A: Increase the amount of institution-generated intellectual property introduced into the marketplace".

Specific project plan and timeline: During the one-year funding period, we will move from Technological Readiness Level (TRL) 2 to 5. We are currently at TRL 2 since we have shown that our pipeline allowed us to develop compounds that prevented Ebola infection in human cells. By month 4, we anticipate having 1-2 chemical compounds that inhibit fungal growth in the laboratory (TRL 3). By the end of the funding period, we anticipate having 5-10 compounds validated in the laboratory (TRL 4) and greenhouse (TRL 5) experiments. That is, compounds that effectively stop fungal infection in potatoes without harming the plants. The mode of action for these compounds is expected to be novel since our protein targets are novel.

Potential economic impact: There are two levels of economic impact. The first is that our project could increase the sustainability of potato production in Idaho. There are several ways that this impact could be realized. (1) Reduce the need for crop rotation. Growing potatoes, a high value crop, more frequently (for example, every three years instead of every four would significantly increase farm revenue. (2) Increase the quality and quantity of seed; this is important since Idaho is the nation's largest producer of seed potato. (3) Reduce crop loss from fungal pathogens; this can vary from 10% to as high as 60%, depending on the fungal disease. (4) Reduce the cost of managing fungal pathogens by developing fungicides that can be applied less frequently, or that use less expensive application methods. (5) An increase in potato production due to any of the above will lead to corresponding increases in the workforce, for example, more farm workers, storage facilities and transportation needs that will benefit the wider Idaho economy. The second economic impact is from the commercialization of novel fungicides. The proposed project has the potential to generate intellectual property in the form of patents for the chemical compounds designed. We anticipate that patented compounds will be licensed to our industrial partner for commercial development and eventual application against fungal pathogens of potatoes, leading to revenue from fungicide sales.

Profit will be realized when Gowan Company LLC (or another agricultural company) purchases or licenses the patent for a compound that we have developed. We anticipate that 5-10 compounds will be ready for patent applications at the end of the funding period, hence profit would most likely be realized 1-3 years after the funding period.

Criteria for measuring success: We will use the metrics shown in **Table 2** to measure success of our project; this table also shows milestones and timelines associated with each metric along with the current value.

METRIC	MILESTONE / TIMELINE	CURRENT
Num. of potential fungicides (primary)	5-10 by end of year 1 (5-10 total)	0
Num. of protein targets identified	10+ in first 4 months (10+ total)	5
Num. of targets validated and screened	1-2 every two months (6+ total)	1
Num. of compounds tested in laboratory	5-10 / month starting month 3 (45-90 total)	0
Num. of compounds tested in greenhouse	5-10 / month starting month 4 (40-80 total)	0

Table 2: List of metrics and milestones for the proposed project. The first row contains the primary metric: the number of compounds that we discover that could be developed into commercial fungicides. Other metrics and associated milestones are listed that will lead us to fulfilling our primary milestone.

Anticipated development challenges/barriers: Unanticipated challenges and barriers may arise during the funding period. We will handle any such issues by discussing them and brainstorming with all team members (**Appendix C**). Our team members already meet regularly to discuss progress and challenges and to brainstorm new ideas. A specific possible challenge will be if the compounds that we identify in our computational screening process are not effective against fungal infection when tested in the lab. In this case, we will broaden the pool of compounds that we test in our molecular modeling simulations and in the laboratory. Another challenge will be if we discover compounds that effectively stop fungal infection in the lab but are toxic to potatoes

in the greenhouse studies. In this case, we will increase the number of greenhouse-tested compounds and also chemically modify the compounds in an attempt to eliminate the toxic effects while retaining efficacy.

Budget: A detailed budget is provided as a separate spreadsheet (**Appendix E**).

Budget justification: The budget justification for our proposed project is shown below in **Table 3**. It includes salary for two participants and lab supplies.

LINE ITEM REQUEST	JUSTIFICATION	TOTAL REQUEST
Personnel (salary and fringe)	Dr. Condon will perform bioinformatics analysis (months 1-4) to identify novel protein targets. Mr. Bates will perform greenhouse experiments to test potential fungicides for efficacy and toxicity (months 7-12).	$77,700
Equipment	None	$0
Travel	None	$0
Participant Support	None	$0
Other Direct Costs	Supplies are requested in order to synthesize chemical compounds and perform laboratory and greenhouse experiments.	$15,000
Total		**$92,700**

Table 3: Budget justification for proposed project.

Project management: Project management will follow the tasks and schedule listed in **Table 1**.

	2024						2025					
TASK	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
Identify new targets												
Validate and screen targets												
Synthesize compounds												
Lab testing of compounds												
Greenhouse testing of compounds												

Table 1: List of metrics and milestones for the proposed project. Highlighted in bold font is the primary metric: the number of compounds that we discover that could be developed into commercial fungicides. Other metrics and associated milestones are listed that will lead us to fulfilling our primary milestone.

Additional institutional and other sector support: There is no support for external partners. The University of Idaho and Idaho State University are providing support to faculty team members in the form of salaries. All faculty members have a percentage of their time (typically ~30-60%) allocated to scholarship that will be leveraged to perform the proposed project. In addition, the Institute for Modeling Collaboration and Innovation is providing the team with meeting facilities containing video conferencing equipment, budgeting support, and devoted infrastructure for dissemination of findings and resolution of any potential conflicts.

Future funding: The next stage of our project will be to expand our screening and experiments to include a broader range of compounds and to use a feedback loop to refine the binding characteristics of our compounds. By the end of the funding period, we anticipate submitting proposals to the Idaho HERC IGEM (Initial Startup track). If we are able to make sufficient progress to be competitive, then we will apply for the NSF and USDA Small Business Innovation Research (SBIR) / Small Business Technology Transfer (STTR) Programs Phase I.

SUMMARY

Potatoes are a staple crop in Idaho, and worldwide, yet they are constantly threatened by fungal pathogens that can lead to enormous yield losses. While fungicides have been developed to combat these pathogens, widespread use has led to the emergence of resistant fungal strains. Treatment options are further limited by the lack of diversity in modes of action with existing fungicides. We seek to revolutionize fungicide development via our unique pipeline that has the potential to lead to the development of novel fungicides with new modes of action. For the proposed Proof of Concept project, we will continue our bioinformatics study to identify potential (novel) protein fungicide targets for the most critical potato fungal pathogens that threaten agriculture in Idaho. We will complete molecular modeling to identify possible inhibitors for these target proteins. Finally, we will synthesize and experimentally validate these inhibitors in laboratory and greenhouse studies. By the end of the funding period, we will have developed a range of promising compounds against multiple protein targets that are ready to be field tested and eventually used to develop commercially available products to combat the most important fungal pathogens of potatoes.

SIGNIFICANCE

In Idaho, potatoes are the backbone of the agricultural economy, with 2023 revenues estimated at $1.3 billion, marking a 14% increase from 2022[1]. In the United States, over 380,000 hectares are dedicated to potato cultivation, generating an annual farm gate value of over $4.5 billion. Worldwide, potatoes are the third most consumed food crop, contributing significantly to global food security. This substantial economic impact underscores the vital role potatoes play in sustaining both regional and national economies.

Despite its economic significance, potato production is threatened by various pests and pathogens. In particular, diseases such as Verticillium wilt, dry rot, Pythium leak, and late blight pose an ongoing challenge to growers[2,3]. These diseases are caused by multiple species of plant pathogenic fungi and fungal-like organisms, leading to annual yield losses estimated at over $5 billion worldwide[4]. In Idaho, the cost to fight fungal pathogens reduces potential revenue by around 11% annually.

Widespread fungicide use has led to the emergence of resistant fungal strains, reducing the ability to control fungal diseases and posing a significant challenge to agricultural sustainability. The Fungicide Resistance Action Committee (FRAC) was established to address the issue of fungicide resistance, working to enhance the long-term utilization of fungicides and to manage the rise of resistance[5]. In 2023, the FRAC code list included 10 modes of action mechanisms for commercial fungicides. This lack of diversity in modes of action available for fungicides calls for innovative approaches to develop novel fungicides that can effectively combat these threats.

RESEARCH & DEVELOPMENT PLAN

Our research aims to revolutionize the field of fungicide development with a unique pipeline that has the potential to lead to the development of novel fungicides with modes of action not previously used to control potato pathogens (**Figure 1**). Our pipeline differs substantially from approaches typically used in agriculture that involve systematically testing large numbers of natural and synthetic chemicals in high-throughput experimental screens. While this approach does lead to new fungicides, the process is labor intensive, expensive, and may not yield new modes of action when chemicals tested are based on existing fungicides. By contrast, our pipeline starts with using bioinformatics to identify potential (novel) plant pathogen protein targets, followed by a combination of molecular modeling and experimental approaches to discover, design, and test inhibitors for these target proteins. Promising compounds are evaluated in the laboratory, followed by greenhouse and field studies to identify efficacious fungicides. Successful compounds will be used to develop commercially available products to combat the most important fungal pathogens of potatoes.

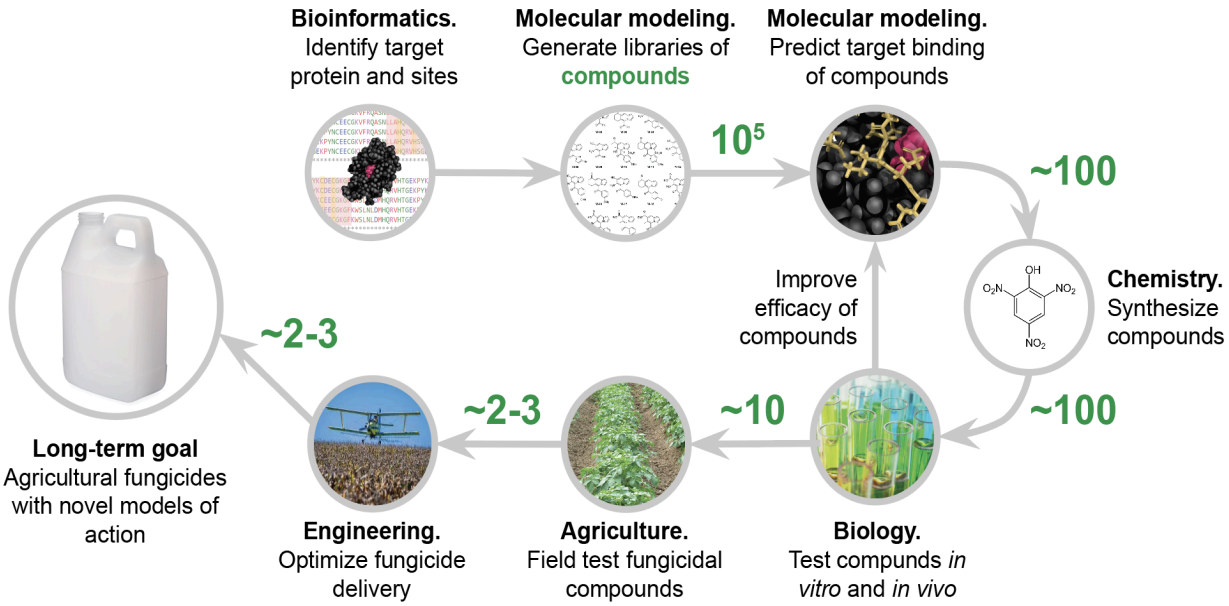

Figure 1: A schematic of our fungicide development pipeline. Our method offers an alternative approach to discovering novel fungicides compared to traditional chemical screening strategies since new protein targets will be identified and used to uncover novel modes of action. The approximate numbers of chemical compounds that will be screened and validated are shown (green).

Fungal pathogens for proposed study

For this research project, we propose to focus on identifying fungicides that are effective against the four major pathogens that cause significant losses in potato production and are the primary reason for the widespread use of fungicides worldwide. These are *Phytophthora infestans* (late

blight), *Pythium ultimum* / *Globisporangium ultimum* (Pythium leak), *Verticillium dahliae* (Verticillium wilt), and *Fusarium solani* (dry rot). The ability to control these pathogens is significantly hampered by the potential for fungicide resistance development and spread, emphasizing the need for novel antifungal compounds with new modes of action. In the case of Verticillium wilt, fungicide options are not available and the growers must rely on fumigation.

Overview of fungicide development pipeline

Our fungicide development pipeline (**Figure 1**) builds on our previous experience with viral pathogens[6–10] and is based on lessons learned from structure-based drug design for human therapeutics[11,12]. Our expertise covers all the developmental stages in the pipeline. (1) Bioinformatics - Dr. Condon: Identify proteins that can be exploited for fungicide development. (2) Molecular modeling - Drs. Frye, Patel, and Ytreberg: Screen millions of chemical compounds to identify those that bind target proteins. (3) Compound synthesis - Dr. Waynant: Synthesize and characterize chemical compounds. (4) Lab tests - Drs. Rowley and Udekwu: Determine the effectiveness of compounds against fungi in cell culture experiments. (5) Greenhouse tests - Dr. Schroeder: Validate compounds as potential fungicides. (6) Field testing - Dr. Schroeder and Gowan Company LLC: Assess real-world performance and environmental impact. (7) Delivery - Dr. Bernards and Gowan Company LLC: Ensure efficient fungicide application in the field. We will maintain a feedback loop that allows for continuous improvement of promising compounds to optimize effectiveness. In the long term, we envision collaborating with Gowan Company LLC to further test and bring fungicide products to the agricultural market.

Preliminary findings

We have completed a preliminary bioinformatics study to identify many protein targets for fungicide development (first stage of our pipeline; **Figure 1**). Our approach identified target genes present in the four fungal potato pathogens, but are not present in humans, other animals, or plants. This improves our chances of developing broad-spectrum fungicides against potato pathogens while minimizing off-target toxicity. So far, this approach has identified six proteins as the most promising targets. Four of these (*FAS1, FAS2, CHS2,* and *YEF3*) have been previously identified as potential drug targets in the scientific literature but do not have inhibitory compounds that are commercially available[15–17]. Two potential targets (*FCY21* and *TRL1*) appear novel, with no citations related to fungicide development.

We have also used molecular modeling to perform a preliminary screening on a library of over 300,000 compounds to predict their ability to bind *YEF3*. This protein target was chosen because *YEF3* has a high-resolution experimental structure and a known enzymatic active site, making it an ideal candidate for our preliminary testing. We are currently studying the simulation results in order to recommend compounds to be synthesized and tested in the laboratory.

Detailed objectives

Objective 1: Expand the fungal target list and determine potential inhibitors. We will continue to use bioinformatics to increase the number of protein targets and to understand their potential for developing fungicides. We will also use molecular modeling to identify possible inhibitors for a range of protein targets. As described above, we have already done this for one target. A similar process will be carried out for additional protein targets. For Objective 1, we anticipate identifying 50 compounds for at least 6 different targets that will be synthesized and tested in the laboratory and greenhouse in Objective 2.

Objective 2: Validate inhibitors and determine their potential for fungicide development. The strongest predicted inhibitors from molecular modeling will be synthesized and tested in the laboratory and greenhouse. Minimal inhibitory assays will determine the concentration required for activity against the plant pathogens listed above. Disease progress assays will be used to evaluate the efficacy of the molecules in reducing the impact of these pathogens and their level

of toxicity to potato plants. Compounds validated in the laboratory and greenhouse that inhibit fungal infection and are non-toxic will enter a feedback loop where molecular modeling is used to suggest possible improvements, and these new compounds are then synthesized and tested. This process will be iterated to generate compounds with the highest potential for fungicide development.

The role of our industry partner Gowan Company LLC will be collaborating and advising during the funding period. They have extensive experience turning high-efficacy chemical compounds into fungicide products. In the future, we anticipate partnering with them to help turn the compounds we generate into commercial fungicides and also work on effective methods for the delivery of these fungicides to the fields.

ANTICIPATED OUTCOMES

Upon successfully completing our project, we will have developed compounds with novel modes of action and high efficacy against fungal disease in potatoes. In the long term, we envision bringing these compounds to market as agricultural products. During the funding period we will have identified novel protein targets and used molecular modeling to identify a broad range of chemical compounds that bind these targets. We will have synthesized these compounds and performed laboratory and greenhouse experiments to test their ability to inhibit fungal growth and determine potential off-target toxicity to plants. Promising compounds will have been optimized to increase their efficacy as fungicides. High-performing inhibitory compounds will have been optimized for delivery in the field.

We anticipate that our pipeline will have broad applicability beyond potato fungal pathogens. For example, the pipeline could be modified to discover inhibitory compounds for bacteria, viruses, nematodes, and insects that significantly reduce agricultural productivity for a wide range of agricultural products.

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APPENDIX A: FACILITIES, EQUIPMENT AND OTHER RESOURCES

Scientific Environment

The University of Idaho (UI) has a rich research environment that is well suited for interdisciplinary studies in biomedical research. It is a high research activity, land-grant institution committed to undergraduate and graduate education, and includes the medical and veterinary education programs for the state of Idaho. Researchers have access to world-class core facilities (see Other Resources), and UI has infrastructure in place to support successful faculty research and promotes a supportive and collaborative research environment through workshops, socials, seed grant competitions, and equipment/infrastructure grant opportunities. For example, the Office of Research and Economic Development (ORED) includes the Research and Faculty Development (RFD) team: a five-person staff dedicated to supporting all stages of individual investigator proposal development, as well as interdisciplinary, collaborative team proposal efforts. They provide assistance with proposal writing and development, search for funding opportunities, and review proposals.

Center for Modeling Complex Interactions / Institute for Modeling Collaboration and Innovation

Dr. Ytreberg is Associate Director for, and other team members are participants in the Institute for Modeling Collaboration and Innovation (IMCI) at UI. The mission of IMCI is to foster a zero-barrier culture where modelers engage in interdisciplinary research to solve real-world problems. IMCI strives to make modeling central to research at the University of Idaho. It provides access to its modeling 'brain core,' develops initiatives in targeted areas of modeling, and establishes interdisciplinary teams to address real-world problems. IMCI is located in the Integrated Research and Innovation Center (IRIC) at the University of Idaho, which opened in 2017 to facilitate discovery-based or interdisciplinary research across a broad spectrum of science, engineering, and other disciplines. The total space in IRIC assigned to IMCI is over 3,000 sq. ft. In addition to this assigned space, IMCI has access to a shared kitchen area, conference rooms, and many additional interaction spaces.

CMCI/IMCI brings together 70 faculty from Animal and Veterinary Science; Biological Engineering; Biological Sciences; Business; Chemical and Materials Engineering; Chemistry; Computer Sciences; Entomology, Plant Pathology & Nematology; Fish & Wildlife; Forest, Rangeland & Fire Sciences; Geography; Library; Industrial Technology; Mathematics; Mechanical Engineering; Movement Sciences; Political Science & Philosophy; Psychology & Communication Studies; Physics; Statistical Sciences; and Virtual Technology & Design. These faculty share an interest in interdisciplinary approaches to address complex biomedical problems. The proposed research will be supported by the Modeling Core and various other core facilities at UI and nearby Washington State University (WSU). Furthermore, the UI campus has a rich breadth of interdisciplinary and collaborative research that is greatly enhanced by CMCI/IMCI.

<u>CMCI Modeling Core</u>:

The Modeling Core is an innovative way to promote interdisciplinary research by using modeling as a common denominator to generate connections among investigators and between projects. Building on the modeling theme, the Core is 1) a physical space, 2) an arrangement of researchers around a nucleus of Core Fellows and supporting faculty, and 3)

a culture of intellectual exchange all geared toward solving complex, biomedically relevant problems.

Other Interdisciplinary and Collaborative Groups at UI

CMCI follows the example of the UI Institute for Bioinformatics and Evolutionary Studies (IBEST)—an extremely productive interdisciplinary research group focused on real-time evolution. IBEST was previously funded by a COBRE grant that has completed Phase III. UI also has an INBRE (IDeA Network of Biomedical Research Excellence) award that promotes the development of biomedical research programs at UI and throughout the state of Idaho. As a relatively small campus, there are no geographic obstacles to interdisciplinary research; in fact, close proximity leads to more spontaneous interactions among researchers in places like the coffee shops in the UI Commons and the IRIC than is possible when people are widely spaced. In addition, UI is eight miles from WSU in Pullman, which houses another impressive cadre of biomedical investigators. The close proximity of these two institutions allows regular collaboration among faculty and shared resources that benefit faculty at both universities. Researchers at UI are also involved in interdisciplinary projects with institutions across the country through several NSF programs, including BEACON, an NSF Science and Technology Center, and an EPSCoR Track II grant, “Using Biophysical Protein Models to Map Genetic Variation to Phenotypes.” The robust intellectual environment at UI promotes regular interdisciplinary exchanges among faculty of all academic disciplines. The Malcolm M. Renfrew Interdisciplinary Colloquium is an ongoing series of weekly interdisciplinary lectures by distinguished members of the UI faculty and staff. In addition to the existing resources at UI, CMCI provides opportunities for interdisciplinary exchange through seminars, visiting faculty, brown bag lunches, and training workshops.

Investment in the success of early stage investigators

The University of Idaho (UI) has an extensive set of policies and programs designed to help facilitate the successful transition of early stage investigators to independence. UI operates with the philosophy that investing in early stage investigators so that they can start strong will greatly benefit the future of the investigator’s career and the University as a whole. UI recognizes that starting a new research program is a very time-intensive effort, and as such, gives new faculty members time sheltered from teaching assignments to establish their research programs. Senior departmental faculty members also serve as mentors to new faculty and help them to learn how to navigate the university, design independent research programs, and compete successfully for tenure. Pre-tenured faculty members in some departments also meet regularly as part of a peer group to share experiences and learn from each other. The compact size of the campus also permits regular interactions between individuals

Several established core facility laboratories are available to help conduct research projects, including computational, genomics, and imaging core facilities (see Other Resources). The availability of these facilities allows early stage investigators to immediately begin conducting research. Research is supported by start-up funds, and ORED also has a campus-wide competitive seed grant program that will fund early stage investigators who need preliminary data before seeking external funds. For early stage investigators, ORED’s RFD team offers faculty development workshops and seminars related to developing competitive proposals and facilitates contacts with funding agency program officers. IBEST and ORED offer competitive pilot grants for sequencing, as well as larger pilot grants that are intended to facilitate the development of novel lines of research. The trainees of early stage investigators, both graduate

and undergraduate, are supported by departmental fellowships, and early stage investigators can take advantage of training by UI Employee Development and Learning in how to manage and develop a rapport with the students and staff they mentor and oversee. Travel and training awards are made available to new faculty to attend meetings or receive additional training that will enhance their research career. The Office of Sponsored Programs and departmental administration staff have training sessions and offer personalized assistance to help new and established faculty submit grant applications. In sum, UI is devoted to the success of early stage investigators in both their academic and research endeavors.

Experimental resources

Rowley laboratory

The Rowley laboratory operates three negative-pressure laboratory spaces within the Department of Biological Sciences at the University of Idaho. These three laboratories have a combined footprint of 2,100 sq. ft., including a 4°C cold room. All three spaces are approved for BSL-2 work by the UI Institutional Biosafety Committee, meeting all requirements in the CDC Biosafety in Microbiological and Biomedical Laboratories (BMBL) version 6. Each laboratory has been provided with ergonomic pipettes (VistaLabs) and saddle stools to reduce worker fatigue and repetitive strain injury and have sufficient space for the personnel supported by this proposal to have their own laboratory workbench and desk. All employees are trained to work in a BSL2 environment, meeting all the requirements of the Institutional Biosafety Committee to ensure safety and biological containment. These laboratories use one of four industrial autoclaves available within the department to sterilize biohazard waste, and UI Environmental Health and Safety performs chemical waste disposal. The laboratory is equipped with the following computing infrastructure: for general use in the lab, an iMac (OSX, Processor, 2.8 GHz Intel Core i5; Memory, 8 GB 1867 MHz); three MacBook Pro (13-inch, 2020) laptops (OSX, Processor, 1.4 GHz Intel quadcore i5 Processor; memory, 8 GB 2133MHz) for use by undergraduate students; a MacBook Pro (15-inch, 2019) laptop (OSX, Processor, 2.3 GHz 8-Core Intel Core i9; Memory, 16 GB 2400 MHz) for the lab technicians; and a Macbook pro (16-inch, 2020) laptop (OSX, Processor, 2.6GHz 6-core Intel Core i7; Processor; memory, 32 GB 2133 MHz) for my own use. The lab has a subscription to Readcube Papers (referencing software), Sequencher (DNA sequence analysis), PyMol (protein visualization), and other free software for data analysis (e.g., Fiji, ApE, Seaview, BBedit, MEGAX, Rstudio, Gpower, etc.).

Schroeder Laboratory

Dr. Schroeder's Plant Pathology, microbiology and molecular biology research program is housed in the Agricultural Sciences Building in the Dept. of Entomology, Plant Pathology and Nematology. There are 18 faculty located on the Moscow, ID main campus as well as at research and extension centers in Aberdeen, Idaho Falls, Kimberly, Parma and Twin Falls. Research programs span basic and applied science with interdisciplinary research in biotechnology as well. Dr. Schroeder is assigned a 625 ft^2 laboratory in room 351 of the Agricultural Sciences Building on the University of Idaho campus that is located in departmental space, with shared access of 351 and 349 in the Agricultural Sciences Building. The laboratory is well equipped to complete investigations into plant pathology, microbiology and molecular biology. Dr. Schroeder has a BSL-2 plant pathology, microbiology and molecular biology research program at the University of Idaho. Major equipment available for this project includes a Biosafety cabinet, thermocycler unit for PCR assays, agarose gel electrophoresis units and power supplies, a BioRad Unit to visualize DNA and store the images, a hybridization oven for

blotting membranes, 2 microcentrifuges, an autoclave, 2 incubator/shakers, 2 laboratory shakers, 5 incubators of various types, a Virtis cell sonicator, an electronic balance, a spectrophotometer, a spiral plater, a BioRad Gene Pulser electroporation unit, access to a biological safety cabinet, a 4°C refrigerator, a large 4°C walk in cooler, 2 -20°C freezers, and a So-Low -80°C freezer.

University of Idaho Greenhouse Facilities

The Sixth Street Greenhouse covers over 20,000 square feet, the facility includes: twenty greenhouse compartments varying from 500 to 1,000 square feet; 15,000 square feet total; thirteen reach-in or walk-in growth chambers of various sizes; 700 square feet total; two vernalization chambers, 40 square feet total; seed storage chamber with humidity control; walk-in cold room for sample storage; autoclave; large head house with space for classes, work and storage. Greenhouse compartments and growth chambers are programmed and operated using the fully automated Argus Titan environmental control system. Some compartments are equipped with automated misting and irrigation benches. All are equipped with lighting such as LED, fluorescent, high-pressure sodium and metal halide. The greenhouse has its own weather station that records temperatures, humidity, wind speed and direction and photosynthetically useful sunlight. An advanced recordkeeping system permits access to historical environmental data and a comprehensive alarm system ensures a reliable growth environment in all chambers and compartments.

Computational resources

IBEST Computational Resources Core:

The IBEST Computational Resources Core (CRC) serves as the computational backbone of evolutionary and computational biology research at UI. It provides investigators with reliable and highly available state of the art high performance computing and large data storage capabilities for use in analyzing and managing large volumes of research data. We provide the computational tools required for processing data across all stages of analysis including the earliest stages of processing raw data generated by various sequencing platforms to the genomic, metagenomic, and phylogenetic analysis required to transform biological questions into meaningful results. Users of the core run jobs that may use hundreds of processors in parallel or large memory allocations and may run require weeks to complete. Typical high-end projects include mathematical modeling, machine learning, phylogenetic analyses, genome assembly, protein structure modeling, and computational biology simulations.

The CRC is explicitly designed to manage the complex computational and storage requirements for the IBEST researchers and core facilities with very high data reliability and availability. The core contains an advanced mix of high-performance computing clusters, powerful servers and reliable data storage components as well as the knowledge and technical skills required to compress years of analysis into days. The National Institutes of Health and the Murdock foundation have provided funding for the core. All equipment is housed in a state-of-the-art data center provided by the University of Idaho.

Data Center: The IBEST Computational Resources Core data center is a 1400 square foot facility in Room 124 in McClure Hall on the University of Idaho campus that has been specifically designed and renovated for the core. Optical fiber and copper interconnections provide 1-25 Gb/s data transfer rates within the core, which is connected to the 10Gb/s university backbone and from there to Internet2. This room has a dedicated 80KVa UPS with

three-phase power and four-forced air handlers attached to redundant university chilled water systems. Core facility staff has office space in room 123 McClure Hall and 441D Life Sciences South.

Condominium Service: The IBEST Computational Resources Core provides space within the Data Center and expert systems administration for computing systems purchased by other entities. Equipment purchased by CMCI during Phase I is housed with the CRC under this service. These include two Dell PowerEdge R730 Rack Servers and two Thinkmate Supermicro SuperServer nodes.

Computing Systems: The CRC has one large computer cluster for research and genomic data analysis. Our main cluster provides over 1500 processor cores and over 6 terabytes of system memory. The servers that comprise the cluster are connected with 40Gb/sec QDR (Quad Data Rate) Infiniband for inter-node communication and 1Gb/sec ethernet for management. The modular design of this cluster, primarily enclosures (blade chassis) and blade servers, makes it possible to service or upgrade components without interrupting our users. Removable and redundant fans and power supplies located at the back of the enclosure provide easy access and replacement without powering down individual systems, and each enclosure contains its own network components to maximize inter-enclosure server communication. Components include Dell M1000e blade enclosures with various blade servers, Dell R730 and R815 rack servers, and Supermicro 5018D-FN4T servers, and 6 Supermicro GPU servers.

The CRC also maintains 12 servers (various Dell and Supermicro rack servers) that are not connected to the cluster systems for jobs that require very large shared memory machines (such as distance-based phylogenetic analyses, genome assembly, and molecular simulations), for software development, and for investigators who are unfamiliar with or do not require a cluster environment. The most powerful servers in this group each contain 64 cores and 1 terabyte (1000GB) of system memory. These powerful servers are used heavily for hybrid sequence assembly Illumina data.

Because this scale of operation falls well outside typical University of Idaho information technology and computing services, we maintain our own support infrastructure. These include several servers for storage and authentication of user accounts (LDAP), domain name resolution (DNS), internet address assignment (DHCP) and secure connections to private networks (VPN). We also provide web and database services for online documentation.

Data Storage Systems: The CRC has three distinct classes of data storage. The first group is our high-performance storage (200TB available). This storage comprises faster but more expensive disk drives and multiple control systems that are linked together through a distributed file system (Lustre) that allows us to group storage components into logical units. This makes it possible to access portions of data from multiple storage devices and aggregates data reading and writing across multiple disk drives and network connections, thereby increasing overall performance. Metadata servers contain typical file system information such as ownership permissions, and physical location. We have multiple metadata servers working in parallel in order to recognize failures and automate device control to minimize staff intervention and disruption of services. Each individual disk storage system (array) combines multiple disks into a single logical unit (RAID), which provides

redundancy on a disk level. Components currently include Dell MD3420 storage arrays, Dell R515, R510, R630 servers, and Supermicro 5029P servers.

The second group is our commodity storage (1.9PB gross). This storage group uses cheaper, but slower, disks to house the majority of user data. We currently have two distributed file systems in service: a Gluster distributed file system (600TB gross) with ZFS for data integrity, redundancy and real-time compression; and a Ceph distributed file system (1.3 PB gross). We are in the process of migrating all data to the Ceph system because of its increased performance and reliability. Components currently include various Dell and Supermicro rack servers.

The third storage group comprises our backup storage systems (898TB gross, 630TB of which is off-site). We back up user data regularly to an offsite location on commodity disk using ZFS snapshots. Components include Storinator Storage Pods and a Supermicro rack server.

Science DMZ: Working with the UI Networking team, we have set up a Globus data transfer node on the university's science DMZ network – which allows for high-speed data transfers on the Internet2 backbone. These servers make it possible to connect safely to computational cores at collaborators' institutions and share data.

Idaho National Laboratory:

Nuclear Science User Facility (NSUF) High Performance Computing (HPC) resources offered through Idaho National Laboratory provide scientific computing capabilities to support efforts in advanced modeling and simulation. These resources support a wide range of research activities, including performance of materials in harsh environments (such as the effects of irradiation and high temperatures), performance of existing light water and advanced nuclear reactors, and multiscale multiphysics analysis of nuclear fuel performance.

Ytreberg and his team members have user accounts on INL HPC that makes computing resources available to industry, universities, national laboratories, and federal agencies to support research and development. Access is generally granted for research related to the DOE Office of Nuclear Energy and INL's mission focusing on nuclear energy development, workforce development, and education.

Resources available at INL HPC:

Sawtooth is an HPE SGI 8600-based system with 99,792 cores, 403 TB of memory and a LINPACK rating of 5.6 Petaflop/s. Sawtooth's network is a nine-dimensional enhanced hypercube utilizing EDR and HDR InfiniBand. Individual compute nodes contain dual Xeon Platinum 8268 processors with 24 cores each. The majority of compute nodes contain 196 GB of memory while twenty-seven contain 384 GB of memory coupled with four NVIDIA V100 GPUs with 32 GB of on-GPU memory each. Sawtooth came online in late 2019 and ranked #37 on the November 2019 TOP500 list.

Lemhi is a Dell 6420-based system with 20,160 cores, 94 TB of memory and a LINPACK rating of 1.0 Petaflop/s. Lemhi's network is an OmniPath fat tree. Individual compute nodes contain dual Xeon Gold 6148 processors with 20 cores each and 192 GB of memory. Lemhi came online in Fall 2018 and ranked #427 on the November 2018 TOP500 list.

Falcon is a SGI ICE-X distributed memory system with 34,992 cores, 121 TB of memory and a LINPACK rating of 1.1 Petaflop/s. Falcon's network is a seven-dimensional enhanced hypercube utilizing FDR InfiniBand. Individual compute nodes contain dual Xeon E5-2695 v4 processors with 18 cores each and 128 GB of memory. Falcon came online in Fall 2014 and ranked #97 on the November 2014 TOP500 list.

Other resources

All team members have office space, computers with high bandwidth internet, space for lab technicians, postdocs and/or students, and other resources needed to complete the proposed project.

IDENTIFYING INFORMATION:

NAME: Ytreberg, Frederick

ORCID iD: https://orcid.org/0000-0001-7439-8224

POSITION TITLE: Professor

PRIMARY ORGANIZATION AND LOCATION: University of Idaho, Moscow, Idaho, United States

Professional Preparation:

ORGANIZATION AND LOCATION	DEGREE (if applicable)	RECEIPT DATE	FIELD OF STUDY
University of Pittsburgh, Pittsburgh, Pennsylvania, United States	N/A	09/2006	Postdoc in computational biophysics
The University of Maine, Orono, Maine, United States	PHD	05/2000	Physics
Walla Walla College, College Place, Washington, United States	BS	05/1993	Physics

Appointments and Positions

2006 - present Professor, University of Idaho, Moscow, Idaho, United States

2012 - 2018 Associate Professor, Dept of Physics, University of Idaho, Moscow, Idaho, United States

2006 - 2012 Assistant Professor, Dept of Physics, University of Idaho, Moscow, Idaho, United States

2003 - 2006 Postdoctoral Associate, Dept of Comput Biol, University of Pittsburgh, Pittsburgh, Pennsylvania, United States

2000 - 2003 Visiting Assistant Professor, Dept of Physics, Whitman College, Walla Walla, Washington, United States

1997 - 2000 Research Assistant, Dept of Physics, The University of Maine, Orono, Maine, United States

Products

Products Most Closely Related to the Proposed Project

1. Taggart NT, Crabtree AM, Creagh JW, Bizarria R Jr, Li S, de la Higuera I, Barnes JE, Shipley MA, Boyer JM, Stedman KM, Ytreberg FM, Rowley PA. Novel viruses of the family Partitiviridae discovered in Saccharomyces cerevisiae. PLoS Pathog. 2023 Jun;19(6):e1011418. PubMed Central PMCID: PMC10281585.
2. Barnes JE, Lund-Andersen PK, Patel JS, Ytreberg FM. The effect of mutations on binding interactions between the SARS-CoV-2 receptor binding domain and neutralizing antibodies B38 and CB6. Sci Rep. 2022 Nov 5;12(1):18819. PubMed Central PMCID: PMC9637166.
3. Li S, Patel JS, Yang J, Crabtree AM, Rubenstein BM, Lund-Andersen PK, Ytreberg FM, Rowley PA. Defining the HIV Capsid Binding Site of Nucleoporin 153. mSphere. 2022 Oct 26;7(5):e0031022. PubMed Central PMCID: PMC9599535.

4. Beach SS, Hull MA, Ytreberg FM, Patel JS, Miura TA. Molecular Modeling Predicts Novel Antibody Escape Mutations in the Respiratory Syncytial Virus Fusion Glycoprotein. J Virol. 2022 Jul 13;96(13):e0035322. PubMed Central PMCID: PMC9278155.
5. Bazurto JV, Nayak DD, Ticak T, Davlieva M, Lee JA, Hellenbrand CN, Lambert LB, Benski OJ, Quates CJ, Johnson JL, Patel JS, Ytreberg FM, Shamoo Y, Marx CJ. EfgA is a conserved formaldehyde sensor that leads to bacterial growth arrest in response to elevated formaldehyde. PLoS Biol. 2021 May;19(5):e3001208. PubMed Central PMCID: PMC8153426.

Other Significant Products, Whether or Not Related to the Proposed Project

1. Sapozhnikov Y, Patel JS, Ytreberg FM, Miller CR. Statistical modeling to quantify the uncertainty of FoldX-predicted protein folding and binding stability. BMC Bioinformatics. 2023 Nov 12;24(1):426. PubMed Central PMCID: PMC10642056.
2. Barnes JE, Miller CR, Ytreberg FM. Searching for a mechanistic description of pairwise epistasis in protein systems. Proteins. 2022 Jul;90(7):1474-1485. PubMed Central PMCID: PMC9177791.
3. Patel D, Haag SL, Patel JS, Ytreberg FM, Bernards MT. Paired Simulations and Experimental Investigations into the Calcium-Dependent Conformation of Albumin. J Chem Inf Model. 2022 Mar 14;62(5):1282-1293. PubMed Central PMCID: PMC9007495.
4. Patel D, Patel JS, Ytreberg FM. Implementing and Assessing an Alchemical Method for Calculating Protein-Protein Binding Free Energy. J Chem Theory Comput. 2021 Apr 13;17(4):2457-2464. PubMed Central PMCID: PMC8044032.
5. Gonzalez TR, Martin KP, Barnes JE, Patel JS, Ytreberg FM. Assessment of software methods for estimating protein-protein relative binding affinities. PLoS One. 2020;15(12):e0240573. PubMed Central PMCID: PMC7751979.

Synergistic Activities

1. Dr. Ytreberg is a computational molecular biophysicist that uses molecular modeling to understand protein structure, function and interactions with other molecules. He is actively involved in multiple interdisciplinary programs. (i) Associate Director of Institute for Modeling Collaboration & Innovation at University of Idaho. (ii) Faculty advisor for Physics undergraduate and graduate programs, and Bioinformatics and Computational Biology graduate program. (iii) Former PI of NSF EPSCoR Track-2 award with Genome to Phenome theme (ended 2021).
2. He more than 20 years of experience developing, implementing and disseminating free energy and other molecular simulation methodologies.
3. He develops and distributes open source software on GitHub for computational physics and biophysics.
4. He requires students to give presentations and write scientific reports in all upper level and graduate courses that he teaches.

Certification:

When the individual signs the certification on behalf of themselves, they are certifying that the information is current, accurate, and complete. This includes, but is not limited to, information related to domestic and foreign appointments and positions. Misrepresentations and/or omissions may be

subject to prosecution and liability pursuant to, but not limited to, 18 U.S.C. §§ 287, 1001, 1031 and 31 U.S.C. §§ 3729-3733 and 3802.

Certified by Ytreberg, Frederick in SciENcv on 2024-01-19 10:29:08

IDENTIFYING INFORMATION:

NAME: Schroeder, Brenda

ORCID iD: https://orcid.org/0000-0003-1518-6269

POSITION TITLE: Associate Research Professor

PRIMARY ORGANIZATION AND LOCATION: University of Idaho, Moscow, ID, United States

Professional Preparation:

ORGANIZATION AND LOCATION	DEGREE (if applicable)	RECEIPT DATE	FIELD OF STUDY
Washington State University, Pullman, WA, US	PhD.	12/1997	Plant Pathology
North Carolina State University, Raleigh, North Carolina, United States	MS	12/1992	Plant Pathology
University of Wisconsin-Madison, Madison, Wisconsin, United States	BS	12/1989	Natural Science

Appointments and Positions

2014 - present Associate Research Professor, University of Idaho, Entomology, Plant Pathology and Nematology, Moscow, ID, United States

2006 - 2013 Assistant Professor, Washington State University, Pullman, Washington, United States

2002 - 2005 Post Doctoral Research Associate, Washington State University, Pullman, Washington, United States

1998 - 2001 Post Doctoral Research Associate, Washington State University, Pullman, Washington, United States

Products

Products Most Closely Related to the Proposed Project

1. Scholz-Schroeder BK, Hutchison ML, Grgurina I, Gross DC. The contribution of syringopeptin and syringomycin to virulence of Pseudomonas syringae pv. syringae strain B301D on the basis of sypA and syrB1 biosynthesis mutant analysis. Mol Plant Microbe Interact. 2001 Mar;14(3):336-48. PubMed PMID: 11277431.
2. Dung JKS, Schroeder BK, Johnson DA. Evaluation of Verticillium Wilt Resistance in Mentha arvensis and M. longifolia Genotypes. Plant Dis. 2010 Oct;94(10):1255-1260. PubMed PMID: 30743590.
3. Johnson DA, Dung JKS, Cummings TF, Schroeder BK. Development and Suppression of Aerial Stem Rot in Commercial Potato Fields. Plant Dis. 2011 Mar;95(3):285-291. PubMed PMID: 30743499.
4. Sangjan W, Marzougui A, Mattinson DS, Schroeder BK, Bates AA, Khot LR, Sankaran S. Identification of volatile biomarkers for high-throughput sensing of soft rot and Pythium leak diseases in stored potatoes. Food Chem. 2022 Feb 15;370:130910. PubMed PMID: 34788943.
5. Kothawade GS, Sankaran S, Bates AA, Schroeder BK, Khot LR. Feasibility of Volatile

Biomarker-Based Detection of Pythium Leak in Postharvest Stored Potato Tubers Using Field Asymmetric Ion Mobility Spectrometry. Sensors (Basel). 2020 Dec 21;20(24) PubMed Central PMCID: PMC7767497.

Other Significant Products, Whether or Not Related to the Proposed Project

1. Beck K, Reyes Corral CA, Rodriguez-Rodriguez M, May C, Barnett R, Thornton M, Bates AA, Woodhall JW, Schroeder BK. First report of Fusarium proliferatum causing necrotic leaf lesions and bulb rot on storage onion (Allium cepa) in southwestern Idaho. Plant Dis. 2020 Sep 15; PubMed PMID: 32931387.
2. Barrantes-Infante BL, Schroeder BK, Subbotin SA, Murray TD. Afrina sporoboliae sp. n. (Nematoda: Anguinidae) Associated with Sporobolus cryptandrus from Idaho, United States: Phylogenetic Relationships and Population Structure. Phytopathology. 2018 Jun;108(6):768-779. PubMed PMID: 29327647.
3. Schroeder BK, Schneider WL, Luster DG, Sechler A, Murray TD. Rathayibacter agropyri (non O'Gara 1916) comb. nov., nom. rev., isolated from western wheatgrass (Pascopyrum smithii). Int J Syst Evol Microbiol. 2018 May;68(5):1519-1525. PubMed PMID: 29557775.
4. Murray TD, Schroeder BK, Schneider WL, Luster DG, Sechler A, Rogers EE, Subbotin SA. Rathayibacter toxicus, Other Rathayibacter Species Inducing Bacterial Head Blight of Grasses, and the Potential for Livestock Poisonings. Phytopathology. 2017 Jul;107(7):804-815. PubMed PMID: 28414631.
5. Dung JKS, Johnson DA, Schroeder BK. First Report of Pectobacterium wasabiae Causing Aerial Stem Rot of Potato in Washington State. Plant Dis. 2012 Dec;96(12):1819. PubMed PMID: 30727263.

Synergistic Activities

1. Member of the Fungicide Drug Discovery Working Group 2022-2024, University of Idaho

Certification:

When the individual signs the certification on behalf of themselves, they are certifying that the information is current, accurate, and complete. This includes, but is not limited to, information related to domestic and foreign appointments and positions. Misrepresentations and/or omissions may be subject to prosecution and liability pursuant to, but not limited to, 18 U.S.C. §§ 287, 1001, 1031 and 31 U.S.C. §§ 3729-3733 and 3802.

Certified by Schroeder, Brenda in SciENcv on 2024-02-07 01:33:31

IDENTIFYING INFORMATION:

NAME: Rowley, Paul

ORCID iD: https://orcid.org/0000-0002-3590-5139

POSITION TITLE: Associate Proffessor

PRIMARY ORGANIZATION AND LOCATION: University of Idaho, Moscow, Idaho, United States

Professional Preparation:

ORGANIZATION AND LOCATION	DEGREE (if applicable)	RECEIPT DATE	FIELD OF STUDY
Colorado University, Boulder, CO, United States	Postdoctoral Fellow	07/2015 - 01/2016	Molecular Evolution
The University of Texas, Austin, TX, United States	Postdoctoral Fellow	08/2011 - 03/2015	Molecular Evolution
The University of Texas, Austin, TX, United States	Postdoctoral Fellow	01/2009 - 08/2011	Biochemistry
University of Aberdeen, Aberdeen, Aberd., United Kingdom	PHD	06/2008	Molecular Biology
University of Warwick, Coventry, Warks., United Kingdom	BS	06/2002	Microbiology/Virology

Appointments and Positions

2022 - present Associate Proffessor, University of Idaho, Moscow, Idaho, United States
2016 - 2022 Assistant Professor, University of Idaho, Moscow, ID, United States
2007 - 2008 Research technician, University of Aberdeen, Aberdeen, Not Applicable, N/A, United Kingdom
2002 - 2003 Senior Microbiologist, Global Analysis Ltd, Burton-on-Trent, Not Applicable, N/A, United Kingdom

Products

Products Most Closely Related to the Proposed Project

1. Crabtree AM, Taggart NT, Lee MD, Boyer JM, Rowley PA. The prevalence of killer yeasts and double-stranded RNAs in the budding yeast Saccharomyces cerevisiae. FEMS Yeast Res. 2023 Jan 4;23 PubMed Central PMCID: PMC10664976.
2. Taggart NT, Crabtree AM, Creagh JW, Bizarria R Jr, Li S, de la Higuera I, Barnes JE, Shipley MA, Boyer JM, Stedman KM, Ytreberg FM, Rowley PA. Novel viruses of the family Partitiviridae discovered in Saccharomyces cerevisiae. PLoS Pathog. 2023 Jun;19(6):e1011418. PubMed Central PMCID: PMC10281585.
3. Fredericks LR, Lee MD, Crabtree AM, Boyer JM, Kizer EA, Taggart NT, Roslund CR, Hunter SS, Kennedy CB, Willmore CG, Tebbe NM, Harris JS, Brocke SN, Rowley PA. The Species-Specific Acquisition and Diversification of a K1-like Family of Killer Toxins in Budding Yeasts of the Saccharomycotina. PLoS Genet. 2021 Feb;17(2):e1009341. PubMed Central PMCID: PMC7888664.

4. Fredericks LR, Lee MD, Eckert HR, Li S, Shipley MA, Roslund CR, Boikov DA, Kizer EA, Sobel JD, Rowley PA. Vaginal Isolates of Candida glabrata Are Uniquely Susceptible to Ionophoric Killer Toxins Produced by Saccharomyces cerevisiae. Antimicrob Agents Chemother. 2021 Jun 17;65(7):e0245020. PubMed Central PMCID: PMC8218651.
5. Rowley PA, Ho B, Bushong S, Johnson A, Sawyer SL. XRN1 Is a Species-Specific Virus Restriction Factor in Yeasts. PLoS Pathog. 2016 Oct;12(10):e1005890. PubMed Central PMCID: PMC5053509.

Other Significant Products, Whether or Not Related to the Proposed Project

1. Taylor MB, Warwick AR, Skophammer R, Boyer JM, Geck RC, Gunkelman K, Walson M, Rowley PA, Dunham MJ. yEvo: A modular eukaryotic genetics and evolution research experience for high school students. Ecol Evol. 2024 Jan;14(1):e10811. PubMed Central PMCID: PMC10771926.
2. Ellis JR, Bull JJ, Rowley PA. Fungal Glycoside Hydrolases Display Unique Specificities for Polysaccharides and Staphylococcus aureus Biofilms. Microorganisms. 2023 Jan 23;11(2) PubMed Central PMCID: PMC9964650.
3. Li S, Patel JS, Yang J, Crabtree AM, Rubenstein BM, Lund-Andersen PK, Ytreberg FM, Rowley PA. Defining the HIV Capsid Binding Site of Nucleoporin 153. mSphere. 2022 Oct 26;7(5):e0031022. PubMed Central PMCID: PMC9599535.
4. Rowley PA, Ellahi A, Han K, Patel JS, Van Leuven JT, Sawyer SL. Nuku, a family of primate retrocopies derived from KU70. G3 (Bethesda). 2021 Aug 7;11(8) PubMed Central PMCID: PMC8496227.
5. Rowley PA, Kachroo AH, Ma CH, Maciaszek AD, Guga P, Jayaram M. Stereospecific suppression of active site mutants by methylphosphonate substituted substrates reveals the stereochemical course of site-specific DNA recombination. Nucleic Acids Res. 2015 Jul 13;43(12):6023-37. PubMed Central PMCID: PMC4499138.

Synergistic Activities

1. Participated in NSF's Innovation Corps (I-Corps™) in 2022 and 2024 to gain training in strategies for commercializing antifungal compounds that the Rowley laboratory has identified in yeasts. The Rowley laboratory holds a provisional patent in the application of killer yeasts against disease-causing fungi.
2. Mentored 57 undergraduate students' independent research projects in the biosciences, with 21 students awarded independent research funding, 75 student research presentations, and 11 student co-authors on six peer-reviewed publications (2016-present).
3. Developed and implemented undergraduate classes on biochemistry. This includes a non-majors survey class and an upper-division biochemistry class. These classes use a partial flipped classroom model with "clickers" to monitor student knowledge retention (2016-present).
4. Organized and presented public outreach activities in Moscow, Idaho, including mini-symposiums, laboratory tours, research seminars, high school science demonstrations, high school and middle school science research, and local farmer's market displays (2017-present).

Certification:

When the individual signs the certification on behalf of themselves, they are certifying that the

information is current, accurate, and complete. This includes, but is not limited to, information related to domestic and foreign appointments and positions. Misrepresentations and/or omissions may be subject to prosecution and liability pursuant to, but not limited to, 18 U.S.C. §§ 287, 1001, 1031 and 31 U.S.C. §§ 3729-3733 and 3802.

Certified by Rowley, Paul in SciENcv on 2024-02-06 12:32:21

IDENTIFYING INFORMATION:

NAME: Condon, David Edward

ORCID iD: https://orcid.org/0000-0002-3755-7078

POSITION TITLE: Research Scientist II

PRIMARY ORGANIZATION AND LOCATION: University of Idaho, Moscow, Idaho, United States

Professional Preparation:

ORGANIZATION AND LOCATION	DEGREE (if applicable)	RECEIPT DATE	FIELD OF STUDY
University of Pennsylvania, Philadelphia, PA, United States	Postdoctoral Fellow	01/2015 - 11/2017	Genetics and Bioinformatics
University of Rochester, Rochester, NY, USA	PHD	01/2015	Chemistry
Pennsylvania State University, State College, PA, USA	BS	12/2008	Chemistry

Appointments and Positions

2023 - present Research Scientist II, University of Idaho, Moscow, Idaho, United States

2017 - 2022 Lead Computational Bioinformatics Analyst, Sanford Health, Sioux Falls, SD, USA

Products

Products Most Closely Related to the Proposed Project

1. Cherukuri PF, Soe MM, Condon DE, Bartaria S, Meis K, Gu S, Frost FG, Fricke LM, Lubieniecki KP, Lubieniecka JM, Pyatt RE, Hajek C, Boerkoel CF, Carmichael L. Establishing analytical validity of BeadChip array genotype data by comparison to whole-genome sequence and standard benchmark datasets. BMC Med Genomics. 2022 Mar 14;15(1):56. PubMed Central PMCID: PMC8919546.
2. Pinney SE, Joshi A, Yin V, Min SW, Rashid C, Condon DE, Wang PZ. Exposure to Gestational Diabetes Enriches Immune-Related Pathways in the Transcriptome and Methylome of Human Amniocytes. J Clin Endocrinol Metab. 2020 Oct 1;105(10):3250-64. PubMed Central PMCID: PMC7451504.
3. Bansal A, Robles-Matos N, Wang PZ, Condon DE, Joshi A, Pinney SE. In utero Bisphenol A Exposure Is Linked with Sex Specific Changes in the Transcriptome and Methylome of Human Amniocytes. J Clin Endocrinol Metab. 2020 Feb 1;105(2):453-67. PubMed Central PMCID: PMC7046022.
4. Condon DE, Tran PV, Lien YC, Schug J, Georgieff MK, Simmons RA, Won KJ. Defiant: (DMRs: easy, fast, identification and ANnoTation) identifies differentially Methylated regions from iron-deficient rat hippocampus. BMC Bioinformatics. 2018 Feb 5;19(1):31. PubMed Central PMCID: PMC5800085.

Other Significant Products, Whether or Not Related to the Proposed Project

Synergistic Activities

1. I have 8 years experience in bioinformatics and genetics, and 5 years in chemistry. I am able to use my scripting and Linux skills in Perl and Python to manage vast databases of biological data,

and further use my background to identify novel anti-fungal targets. I have previously developed methods and written open-source programs that have been downloaded all over the world, and used for many different applications. I have previously developed these skills to work on a variety of projects, from scientific to medical, in both human and animal. My research has found novel associations in neuronal dysregulation, and the effects of differing diets on the transcriptome and methylome.

Certification:

When the individual signs the certification on behalf of themselves, they are certifying that the information is current, accurate, and complete. This includes, but is not limited to, information related to domestic and foreign appointments and positions. Misrepresentations and/or omissions may be subject to prosecution and liability pursuant to, but not limited to, 18 U.S.C. §§ 287, 1001, 1031 and 31 U.S.C. §§ 3729-3733 and 3802.

Certified by Condon, David Edward in SciENcv on 2024-01-31 20:39:42

APPENDIX C: SENIOR PERSONNEL

Note that three members of our team (PI Ytreberg, Co-PI Rowley, participant Patel) completed the NSF I-Corps training in early 2024.

All team members listed below will contribute toward accomplishing the project's objectives and faculty members at University of Idaho (UI) and Idaho State University (ISU) supervise undergraduate and graduate students. We anticipate that students will be involved in all aspects of the proposed project.

George Newberry, industry partner contact (Gowan Company): Gowan Company will provide expertise in developing fungicides. They will help the research team by advising as we begin to identify compounds that are potential fungicides.

Marty Ytreberg, PhD, PI (Professor, Physics, UI): Dr. Ytreberg will be in charge of overall project management and research direction based on his prior experience running projects with a large number of participants. He will provide expertise in molecular modeling and use computer simulations to screen compounds for protein targets to discover potential inhibitors.

Brenda Schroeder, PhD, Co-PI (Associate Research Professor, Entomology, Plant Pathology & Nematology, UI): Dr. Schroeder will assist Dr. Ytreberg with project management, and will provide expertise in plant pathology. Her lab will perform disease assays in greenhouse experiments to evaluate the compounds for efficacy and toxicity against target plant pathogens.

Paul Rowley, PhD, Co-PI (Associate Professor, Biological Sciences, UI): Dr. Rowley will assist Dr. Ytreberg with project management, and will provide expertise in experimental fungal cellular biology and molecular biology. His lab will test the efficacy of compounds in inhibiting fungal growth in the lab.

David Condon, PhD, Co-PI (Research Scientist II, Institute for Modeling Collaboration and Innovation, UI): Dr. Condon will assist Dr. Ytreberg with project management, and will provide expertise in bioinformatics. He will identify novel protein targets that we can use for screening compounds.

Matt Bernards, PhD (Associate Professor, Chemical & Biological Engineering, UI): Dr. Bernards will provide expertise in biological engineering and will be collaborating and advising. In the future, he will be responsible for improving the delivery of the fungicide.

Leah Frye, PhD (Distinguished Fellow, Retired, Schrödinger, Inc): Dr. Frye will provide expertise in drug design including chemistry and molecular modeling. She will be collaborating and advising the full team during the funding period.

Jagdish Patel, PhD (Assistant Professor, Chemical & Biological Engineering, UI): Dr. Patel will provide expertise in molecular modeling work and with Dr. Ytreberg on computer simulations.

Klas Udekwu, PhD (Assistant Professor, Biological Sciences, UI): Dr. Udekwu will provide expertise in molecular and cellular biology and work with Dr. Rowley on lab experiments.

Kris Waynant, PhD (Associate Professor, Chemistry, UI): Dr. Waynant will provide expertise in chemistry. He will synthesize compounds that are found during our computational screening so that they can be tested in the lab and greenhouse.

Srinath Pashikanti, PhD (Assistant Professor, Pharmacy, ISU): Dr. Pashikanti will provide expertise in medicinal chemistry and work with Dr. Waynant with Dr. Wayant to synthesize compounds.

Gowan®

Letter of support

Gowan company expresses its strong support to Marty Ytreberg on the objective of "Developing Novel Fungicides for Sustainable Potato Production". This initiative holds tremendous potential to address critical challenges in sustainable agriculture and environmental protection, and we commend your efforts in exploring this critical area.

We rely on healthy crops for food, clothing, and even some biofuels. But these crops face a constant threat from fungal diseases, which can devastate yields and cause billions of dollars in losses each year. To combat these threats, we have traditionally used fungicides. However, conventional fungicides often come with downsides, making the development and use of sustainable fungicides crucial for a healthy future.

Developing new sustainable plant protection products offers a promising alternative, with the objective to create solutions less harmful to the environment and human health. We believe is possible to develop effective disease control while promoting biodiversity and soil health. Furthermore, the development of new sustainable plant protection products can reduce the exposure or negative impact of old formulations used in the potatoes field.

Investing in the development of safer plant protection products represents a commitment to a healthier and more sustainable future for agriculture. It can significantly contribute to:

Protecting human health: By reducing exposure to harmful chemicals, sustainable pesticides can minimize health risks for farmers, consumers, and the general public.

Prese ving the environment: Sustainable fungicides can help mitigate soil and water contamination, protect biodiversity, and promote soil health.

Enhancing food security: Sustainable disease control methods can contribute to stable crop yields and improve food security in the long term.

We support the Marty Ytreberg in continuing its efforts to develop new and safer plant protection products. As a team, we are committed to providing consulting to support the completion of this project This initiative represents a crucial step towards building a more sustainable and resilient agricultural system that benefits Idaho production and other regions. We are confident that this investment will produce significant results for generations to come.
Thank you for your time and consideration.

Sincerely,

KARTIK ANAND
02/16/24

370 South Main Street
Yuma, AZ 85364
928.819.1534
gowanco.com

FORM D: IGEM-HERC Full Proposal Budget Sheet

Track (select one): *Proof of Concept*
PI First & Last Name: F. Marty Ytreberg
Project Title: Developing Novel Fungicides for Sustainable Potato Produ
Milestone description (if applicable N/A

Insert more rows in each section, as needed. *Copy/paste cell formulas, as needed.*
Do not remove or hide rows. *Shaded areas have preset formulas.*

Personnel

Name	FTE (opt)	Months	Base Salary	Salary Request
David Condon, Co-I		4	$105,000.00	$35,000.00
Austin Bates, Lab Tech		6	$40,000.00	$20,000.00
		1	$0.00	$0.00
		1	$0.00	$0.00
		1	$0.00	$0.00
		1	$0.00	$0.00

Equipment

Item Description	Units	Unit Cost
	1	
	1	
	1	
	1	
	1	
	1	

Travel

Tentative Date(s)	# persons	Total days	Transit cost/ person	Lodging/ day

Participant Support

Description	# persons	Cost/ Stipend

Other Direct Costs

Item	Units	Cost
Materials/ Supplies	1	$15,000.00
Publication Charges	1	
travel here)	1	
Computer Services	1	
Subcontract 1	1	
Subcontracts 2		
$1,000)	1	
Other	1	
Other	1	
Other	1	

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See cell notes for additional information.

Fringe Rate	Other Ben Rat	Fringe Request	**Total**
41.30%		$14,455.00	**$49,455.00**
41.30%		$8,260.00	**$28,260.00**
		$0.00	**$0.00**
		$0.00	**$0.00**
		$0.00	**$0.00**
		$0.00	**$0.00**
			$77,700.00

	Total
	$0.00
	$0.00
	$0.00
	$0.00
	$0.00
	$0.00
	$0.00

Meal per diem	**Total**
	$0.00
	$0.00
	$0.00
	$0.00
	$0.00
	$0.00
	$0.00

	Total
	$0.00
	$0.00
	$0.00
	$0.00
	$0.00
	$0.00

	Total	
	$15,000.00	
	$0.00	
	$0.00	
	$0.00	
	$0.00	
	$0.00	
	$0.00	
	$0.00	
	$0.00	
	$0.00	
	$15,000.00	
TOTAL DIRECT COST REQUEST	$92,700.00	