IGEM-HERC GRANT PROPOSAL COVER SHEET

State Board of Education

PROPOSAL NUMBER: (to be assigned by HERC)	AMOUNT REQUESTED: $2,100,000

TITLE OF PROPOSED PROJECT: Boise State University Food and Dairy Innovation Center

Our vision is to **create a Food and Dairy Innovation Center (FDIC)** at Boise State University. The FDIC will utilize science and technology to transcend the normative standards of fundamental and applied science in food and dairy sectors. This shift is required to catalyze the transition in Idaho's food and dairy processing industries by creating innovative technologies, providing food safety and food security training, and educating the next generation of workers to be prepared to lead in a high-tech, artificial intelligence (AI) dominated work environment. The FDIC will be a public-private lightning rod to spark economic development for all of Idaho. The FDIC builds on existing strengths at Boise State University, the University of Idaho, and Idaho State University, with the goal of becoming a nationally-recognized resource for research and development, for workforce training programs, and for driving economic success for Idaho industry. The objectives of FDIC are to advance and create new processing technologies, establish a robust employee pipeline from university to private sector, and generate know-how and implementation of modern technology aimed at reducing usage of critical natural resources.

PROJECT START DATE: 7/1/2021	PROJECT END DATE: 7/1/2024
NAME OF INSTITUTION: Boise State University	DEPARTMENT: Chemistry & Biochemistry
ADDRESS: 1910 University Drive, Boise, ID 83725	
E-MAIL ADDRESS: owenmcdougal@boisestate.edu	PHONE NUMBER: (208) 982-0629

	NAME:	TITLE:	SIGNATURE:
PROJECT DIRECTOR/PRINCIPAL INVESTIGATOR	Owen McDougal	Prof. & Chair	Owen McDougal Digitally signed by Owen McDougal DN: cn=Owen McDougal, o=BSU, ou=Chemistry, email=owenmcdougal@boisestate.edu, c=US Date: 2021.03.30 21:04:29 -06'00'
CO-PRINCIPAL INVESTIGATOR	Julia Oxford	Dist. Prof. Biological Sciences	Digitally signed by Julia Thom Oxford DN: cn=Julia Thom Oxford, o=Boise State University, ou=Biomolecular Research Center, email=joxford@boisestate.edu, c=US Date: 2021.03.30 22:35:51 -06'00'
CO-PRINCIPAL INVESTIGATOR	Lisa Warner	Asst. Prof. Chemistry & Biochem.	Lisa Warner Digitally signed by Lisa Warner Date: 2021.03.30 12:27:46 -06'00'
CO-PRINCIPAL INVESTIGATOR	JoAnn Lighty	Prof. & Dean College of Eng.	JoAnn S. Lighty Digitally signed by JoAnn S. Lighty Date: 2021.03.30 21:55:26 -06'00'
CO-PRINCIPAL INVESTIGATOR	Jim Browning	Prof. & Asst. Dean College of Eng.	Jim Browning Digitally signed by Jim Browning Date: 2021.03.30 21:45:24 -06'00'
Authorized Organizational Representative	Matt G. Smith Digitally signed by Matt G. Smith Date: 2021.04.01 14:53:31 -06'00'		

Idaho Public Institution	Boise State University
Principal Investigator	Owen McDougal
Project Objective	Create a Food and Dairy Innovation Center at Boise State University
Amount Requested	$2,100,000

Our vision is to **create a Food and Dairy Innovation Center (FDIC)** at Boise State University. The FDIC will utilize science and technology to transcend the normative standards of fundamental and applied science in food and dairy sectors. This shift is required to catalyze the transition in Idaho's food and dairy processing industries by creating innovative technologies, providing food safety and food security training, and educating the next generation of workers to be prepared to lead in a high-tech, artificial intelligence (AI) dominated work environment. The FDIC will be a public-private lightning rod to spark economic development for all of Idaho. The FDIC builds on existing strengths at Boise State University, the University of Idaho, and Idaho State University, with the goal of becoming a nationally-recognized resource for research and development, for workforce training programs, and for driving economic success for Idaho industry. The objectives of FDIC are to advance and create new processing technologies, establish a robust employee pipeline from university to private sector, and generate know-how and implementation of modern technology aimed at reducing usage of critical natural resources. **Figure 1** illustrates our vision to establish a continuum of knowledge: from fundamental to translational to applied, as well as career readiness and workforce preparation, inspired by our industrial partners and the needs of the Idaho economy. The **funds requested** to achieve this vision are **$2,100,000**.

Resource Commitment Summary: Boise State University will provide the site for construction of the Food and Dairy Innovation Center in the new $50M Micron Center for

Materials Research, and space will be available to achieve a **five-year vision of four, 650 sq. ft. laboratory spaces**, ideally suited to promote public-private engagement.

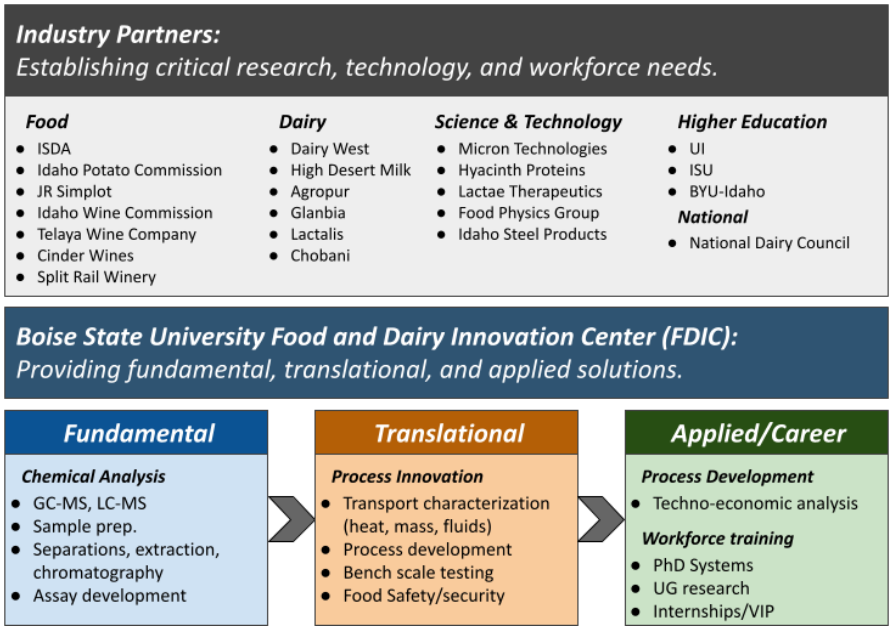


Figure 1. The Food and Dairy Innovation Center (FDIC) vision.

Institution Priorities: Boise State University recently created a new strategic plan, and the FDIC firmly aligns with four of the goals: (1) innovation for institutional impact, (2) improve educational access and student success, (3) advance research and creative activity, and (4) trailblaze programs and partnerships. Furthermore, a taskforce established by President Marlene Tromp, the Rural Industry Cluster Research team, reported on March 10, 2021, the actionable priority for Boise State University to address employment challenges in the dairy and dairy process industries in the Magic Valley. The FDIC will serve as the interface for food and dairy scientists to pursue high risk – high return projects of value to their economic future and train the next generation of high-tech savvy employee in transdisciplinary technical training across academic disciplines including chemistry, microbiology, and process engineering. The work

conducted in the FDIC will complement and leverage the work conducted at the University of Idaho Center for Agriculture, Food and the Environment (CAFE) in Twin Falls, Idaho.

The FDIC will be a scalable laboratory environment, consisting of **three modular 650 sq. ft. units to be established over the three-year duration of the IGEM HERC award**, and a fourth module will be added by 2026. **Module I** will be created using IGEM HERC funds ($650,000) to construct an analytical chemistry laboratory focused on **food research**, where scientists and students can perform routine sample preparation, separation science, spectroscopic analysis, product quality assurance and quality control testing, and scientific data processing. The next two, 650 sq. ft. modules, will be funded by philanthropic, industry, University, and grant infrastructure improvement programs, with an anticipated budget of $650K per lab. **Module II** will be dedicated to **dairy research** for the study of protein and protein powders, pharmaceutical and therapeutic discovery of drugs from agricultural sources, and nutraceutical and nutritional new product development. **Module III** will be a **science and technology** engineering food process design studio, where students will gain experience in food safety innovation, microbiology, project management, new product creation, sanitation, and food regulation standards. The five-year vision is to add **Module IV** as a pilot facility for the fabrication, testing, and training of students in **high-tech, AI**-intensive food and dairy processing equipment, machinery, and computer interface designs. The inspiration for the FDIC is leveraged by nearly a decade of work between PI and Center Director, McDougal, and industry partners representing major constituents of Idaho's agricultural economy, including dairy, potatoes, onions, and wine, complemented by representatives from the science and technology sectors.

Project plan: The FDIC will become a nationally-recognized research environment focused on addressing the needs of Idaho industry in collaboration with representatives from Idaho's

public institutions. The target customers for the center can be broken down into three focus groups: (1) ***Food*** – potatoes, grapes/wine, onions, sugar beets, hops, creation of new technology to improve processing efficiency, conserve natural resources and reduce waste; (2) ***Dairy*** – milk, cheese, yogurt, dairy proteins and protein powders, new product innovation, process improvement methodology, pharmaceutical and therapeutic drug development from agricultural sources, nutraceutical and nutritional products; and (3) ***Science & Technology*** – analytical services including chemical analysis and instrument training, quality assurance & quality control, engineering systems optimization of new and emerging technology in the food and dairy process industry, student training in high-tech, AI-intensive industry system operation, new process technologies, food safety, food security, natural resource conservation, and workforce training in regulatory standards, sanitation, project management and leadership. **Table 1** provides a representative listing of active collaborators and sponsors that support the creation of the FDIC.

Project plan: The project team is committed to addressing the needs of Idaho industry through fundamental, translational and applied techno-economic assessment of past, present and future metrics for sustainability and profitability. PI and Center Director, McDougal and Co-PI Lighty have met extensively with industry representatives across the state to identify gaps in workforce training and emerging worker shortage projections that can be addressed by the establishment of a student pipeline to jobs. Co-PI Warner has designed and delivered professional development courses aimed at job preparedness, internship promotion, project management skills and leadership training. Co-PI Oxford is the director for biomedical research through the INBRE program at Boise State University and she directs the Biomolecular Research Center core facility that complements the FDIC. Co-PI Browning is currently working on a second USDA Food Safety grant to study the removal of bacterial biofilms in food processing

plants, particularly dairy facilities, using an environmentally friendly process. The project team will use the FDIC as an interface between private industry and university core facilities at Boise State University, drawing on expertise from sister institutions, to address the employment demand for technically trained workers, and to promote the economic vitality of Idaho. Our workforce development plan draws on a tradition of transdisciplinary training of students majoring in engineering, biology, physics, chemistry, food processing, and computer science.

Table 1. A sampling of 2021 collaborators in food, dairy and science & technology sectors of the Idaho economy that have expressed their support for FDIC research initiatives (see Appendix E).

FDIC Partner	Position	Industry/Univ.	Role	Strength
Celia Gould	Director	Id. State Dept. of Agriculture	Food: Grant agency & partner	Applied student sponsored research, workforce training
Carolyn Bohach	Dist. Prof., PI and Director	Animal, Vet. and Food Sci.,	INBRE, UI biomed. research	Applied professional development training and internship patron
Frank Muir	President & CEO	Id. Potato Commission	Food: Science advisor	Applied potato advocacy, workforce development
Moya Dolsby	Executive Dir.	Id. Wine Commission	Food: Wine industry advocate	Applied workforce training for winemaking
Emil Nashed	Glob.Sr. VP Prod. Dvlp. Innov. Part.	Dairy Mgmt. Inc.	Prog. Dir. Nat. Dairy Council	Translational, Applied techno-economic partner
Anand Rao	VP of Ingred. Innov.	Agropur US Operations	BUILD Dairy sponsor	Fundamental, Translational tech. expertise, Applied interns
Lenny Bass	Campus & Dairy Acad. Manager	Lactalis Amer. Group	BUILD Dairy and internships	Fundamental, Translational, Applied intern patron
Melanie Krause	Owner and Chief Winemaker	Cinder Wines	Food: ISDA Collaborator	Applied workforce training for winemaking
Earl Sullivan	Owner and Chief Winemaker	Telaya Wine Company	Food: ISDA collaborator	Applied workforce training for winemaking
Jed Glavin	Owner and Chief Winemaker	Split Rail Winery	Food: ISDA Collaborator	Applied workforce training for winemaking
Mike Thornton	Parma Chair & Prof.	UI – Plant Sciences	Food: ISDA Co-PI (pending)	Translational technical expertise, and Applied training
Brandon Carter	VP R&D	High Desert Milk	BUILD Dairy proposal sponsor	Fundamental and Translational protein separation and purity
Loren Ward	Chief R&D Officer	Glanbia Nutritionals	BUILD Dairy proposal sponsor	Applied professional development training and internship patron
Steve Hues	Sr. Member Tech. Staff	Micron Corp. Laboratory	Internship & senior design	Translational, Applied workforce training, internship patron
Jon Snedeker	Research Director	Lactea Therapeutics	Sponsor, drug development	Translational drug development, Applied techno-economic anal.
Chris Hlubb	Founder and CEO	Hyacinth Proteins LLC	Sponsor, drug discovery	Translational drug discovery, Applied techno-economic anal.

Tasks: The tasks and timeline for this IGEM HERC project are detailed in **Table 2**.

Table 2. IGEM HERC timeline and tasks to be performed within the grant award period and projected over a five-year period.

Timeline	Task 1	Task 2	Task 3	Task 4	Task 5
Yr 1: 7/21-7/22	Construct Module I	Hire technicians or postdocs	Recruit students (PhD, MS, Ugd)	Purchase instrumentation	Fundraise for Module II
Yr 2: 7/22-7/23	Construct Module II	Advisory Board guidance	Establish Ambassador Grp	Industry partner intern programs	Fundraise for Module III
Yr 3: 7/23-7/24	Construct Module III	FDIC sustain-ability plan	Grants, contracts, work for hire	Curriculum for employee training	Fundraise for Module IV
	Sustainability beyond IGEM HERC program				
Yr 5: 7/25-7/26	Construct Module IV	New technology, patents	High tech, AI integration	New products, commercialization	Jobs, interns, revenue

Team: The team members for this IGEM HERC proposed project are detailed in **Table 3**.

Table 3. IGEM HERC project team members and reason they are right for the job.

Team member	Position	Program	Role	Strength	Contribution
McDougal	Professor and Chair	Dept. Chemistry & Biochemistry	PI, Center Director	Applied research & student mentor	Project management
Oxford	Dist. Prof. & BRC Dir.	Dept. Biological Sciences	BRC, UI and ISU, INBRE/COBRE	Biomed. drug discovery	UI/ISU network
Warner	Assist. Prof.	Dept. Chemistry & Biochemistry	Research, mentor, worker training	Transdisciplinary teamwork	Internship coordinator
Browning	Professor & Assoc. Dean	Electrical and Computer Eng.	Engineer team lead	Food safety, systems engineer	Engineering processes
Lighty	Prof. and Dean	COEN & Mech. & Biomed. Engineer	Engineering expertise	Techno-economic analysis	High-tech. integration

Advisory Board: To ensure the activities of the FDIC are balanced, wise, informed, impactful and forward-thinking, **Table 4** provides the names of the advisory board members and a description of why they have been selected. The advisory board will meet bi-annually, with one of their meetings coinciding around the annual BUILD Dairy meeting, which will serve as a job fair and industry recruitment forum to identify students for internships.

Table 4. FDIC Advisory Board members and rationale for their selection.

Advisory Board	Position	Experience	Role	Strength	Contribution
T. Gilton	Partner WRVI Capital	Vice President R&D at Micron (25 yrs), Sr. Dir. at Apple	Science and Technology	Industries of the future, high tech, AI	Chair – Advisory Board
E. Bastian	Dir. W. Dairy Ctr, VP Innov. Partnerships Dairy West	Sr. Vice President R&D Glanbia (18 yrs)	Dairy Industry	Research sponsor, internships, jobs	Advisory Board Member
J. Gratzek	Principal & Technical Dir., Food Physics Gp	VP Res., Innov. & Qual. SunOpta (5 yrs) , Dir. R&D Gen. Mills (11 yrs)	Food Process Industry	Food technology & process, regulation, sanitation	Advisory Board Member

Potential economic impact – Processing of food and dairy contributes more than half of the nearly $8 billion agricultural component of the Idaho economy. The FDIC and its focus on fundamental knowledge to commercial utilization, as well as education and job training, through its partnerships with industry and academia, will position Idaho food and dairy processing companies to be leaders in science and technology, and in building a workforce for all of Idaho. In addition, with a focus on resource utilization, high-tech training and AI solutions, the FDIC will facilitate the modernization of industry to meet eminent challenges, like the rising cost of water and energy. Two examples of how the FDIC will impact the Idaho economy are: (1) expansion of participation in the BUILD Dairy program to recruit and train the next generation of Idaho dairy workers, and (2) creation of new technology, know-how, processing efficiency, and natural resource conservation in the production of the world's best potato chip using pulsed electric field system treatment, as described in a recent IGEM Commerce proposal by the PI and Food Physics Group, and by using new bacterial biofilm prevention and removal systems in food processing facilities thereby greatly reducing water and chemical usage. It is the direct benefit to the Idaho economy that has advanced this proposal to warrant your consideration.

Criteria for measuring success: The tasks listed in **Table 2** provide an overview of measurable work to be completed during the course of this IGEM HERC award. **Table 5** summarizes the metrics by which the success of this proposal will be measured.

Table 5. Specific, objective, measurable, and realistic metrics to assess success of this project.

Metric	Year 1	Year 2	Year 3
FDIC	Construct Module I	Module II	Module III
External Funding	$500K	Goal of $1M	Goal of $1.5M
Students Trained in FDIC	3-5	5-10	10-20
Patents & publications/yr	2-4	3-5	5-10
Grants & funding	6	10	12
Internships & Jobs	2-4	5-10	10-20

IGEM-HERC – FDIC - PROPOSAL BUDGET AND BUDGET JUSTIFICATION

Name of Institution: Boise State University

Name of Project Director: Owen McDougal

A. PERSONNEL COST (Faculty, Post-Docs, Graduate/Undergraduate Students)

Name/ Title	Salary/Rate of Pay	Fringe	Dollar Amount Requested
PI Dr. Owen McDougal (0.15 FTE as Director; IGEM reporting; Program Oversight)	$49,600/3 years	$16,300	$65,900
Co-PIs Dr. JoAnn Lighty (1.5 wks/yr salary) & Dr. Lisa Warner (1 mo. summer/yr)	$47,800/3 years	$15,900	$63,700
Two PhD Graduate Students – GRA1 in Food/Dairy research & GRA2 Engineering	$150,000/3 years	$10,500	$162,500
Four Summer Undergraduate Fellowships – 2 Food/Dairy research & 2 Engineering	$69,200/36 weeks	$7,000	$76,200
Two Research Technicians or Postdocs – Tech1/Module I/II; Tech II/Module III	$309,100/3 years	$144,100	$453,300

% OF TOTAL BUDGET:	39%	**SUBTOTAL:**	$821,600

B. EQUIPMENT: (List each item with a cost in excess of $1000.00.)

Item/Description	Dollar Amount Requested
Agilent GC-MS (8890 GC – 5977B MS) – Quote in Appendix E; food and dairy chemistry analysis	$125,000
Agilent LC-DAD-RI-MS – Quote in Appendix E; food & dairy chemistry analysis (sugars, proteins, lipids, etc.); shipping	$210,000
Cell Culture - (Labconco™ Purifier™ Logic™+ Class II A2 Biosafety Cabinets, 3 ft. Width ($12,100)) + SHEL LAB® SCO6AD High Heat Decontamination CO_2 Incubator 5.9 Cu. Ft. ($6,500) – drug development bioactivity assessment	$18,600
Techno-economic analysis software ($15K/yr - YR2 & 3) – Lighty – modeling of water & energy efficiency in processing	$30,000
Thermo Scientific™ Sorvall™ ST 16 Centrifuge and Rotor Packages ($7,000); American Biotech Supply Premier Stainless Steel Solid Door Laboratory Freezer (-20°C), 23 Cu. Ft. ($5,200); American Biotech Supply Premier Laboratory Refrigerator ABT-HC-SSP-23, 23 Cu. Ft. ($4,000); Global Industrial™ Ultra-Low Temperature (-80°C) Undercounter Lab Freezer, Solid Door, 3.5 Cu.Ft. ($7,000); Thermo Scientific™ Precision™ General Purpose Water Bath (2L) ($1,000).	$21,200
Buchi Mini Spray Dryer B-290 – protein powder, new product development, therapeutic drug studies	$22,000
SUBTOTAL:	$426,800

C. TRAVEL:

Dates of Travel (from/to)	No. of Persons	Total Days	Transportation	Lodging	Per Diem	Dollar Amount
8/10 - 14/2022 IMPA conference, Sun Valley, ID	5	5	$300 2 cars - mileage	$1,200 2 rooms	$300 $60/day	$1,800
8/07 – 10/2023 IMPA	5	5	$300	$1,200	$300	$1,800
ADPI 2024 – venue not set yet for 2024	4	5	$6,000 Domestic air fare	$2,000 Chicago-like	$1,200 $60/day	$9,200
					SUBTOTAL:	$12,800

D. Participant Support Costs:

	Dollar Amount Requested
1. Stipends	
2. Other: Graduate student health insurance (2 students for three years)	$22,400
SUBTOTAL:	$22,400

E. Other Direct Costs:	Dollar Amount Requested
1. Materials and Supplies: Funds to support ongoing activities in food ($20K), dairy ($20K), and engineering ($20K)	$60,000
2. Publication Costs/Page Charges (Publications costs are paid for through research support at BSU)	
3. Consultant Services: **Advisory Board Meetings** – bi-annual meetings, job fair, alignment with annual BUILD Dairy meeting, 3 members, all in Idaho (Boise and Twin Falls); funds for meals, meeting rooms, materials & supplies, reimbursement ($3,000/yr for 3 yrs)	$9,000
4. Computer Services	
5. Subcontracts	
6. Other (specify nature & breakdown if over $1000) **Recharge Center Fees**: Biomolecular Research Center access to LC-TQMS, confocal microscope, CD, etc. **Module I Lab Infrastructure**: construction of Module I; countertops; cabinets; plumbing fixtures; fume hoods, etc. **PhD Graduate Student Tuition**: 2 graduate students for three years each (6 semesters of tuition/fees/health insurance)	 $33,500 $650,000 $63,900
SUBTOTAL:	$816,400
F. Total Costs: (Add subtotals, sections A through E) **TOTAL:**	$2,100,000
G. Amount Requested: **TOTAL:**	$2,100,000
Project Director's Signature: 	Date: 3/31/2021

Budget justification

The budget justification has been included in the above two IGEM budget forms, with instrument quotes at the end of Appendix E. The $2.1M budget is split into five main categories: (1) personnel (PI, 2 x Co-PIs, 2 graduate students, and 4 undergraduates) at 39%; (2) infrastructure for Module I, cost based on second floor lab cost and updated estimate (31%); (3) instrumentation & equipment (20%); (4) supplies and access to complementary resources (BRC recharge center) for research activity (5%); and (5) miscellaneous expenses for conference travel, graduate student tuition and health insurance, and Advisory Board meetings (5%).

Institutional commitment

The FDIC will be housed in the new Micron Center for Materials Research building. Deans Lighty and Durham have the vision that the ten modules on the third floor of the new building, which remain to be built-out (the space is currently shelled), will be used to bridge science and engineering. The FDIC is a perfect example of the need for this type of synergy. They have allocated up to four modular units in the new building to the FDIC, at a footprint of 650 sq. ft. per module. This is the premiere research space at the university and has been carefully designed as the most modern, technologically advanced, environment available on the campus. PI McDougal will serve as the Director of the FDIC. The Center will report to the Dean of the College of Arts and Sciences with secondary reporting to the College of Engineering.

11. Additional institutional and other sector support

Other sector support includes: (1) dairy industry research priorities, internship opportunities, and employment of BSU students will be provided by the VP for Innovation Partnerships and Director, Western Dairy Center, Dr. Eric Bastion (FDIC Advisory Board Member), (2) food process industry perspectives and research project management will be provided by Principal and Technical Director of Food Physics Group, Dr. Jim Gratzek (Advisory Board Member), (3) science and technology modernization of food and dairy process industry foresight will be provided by Dr. Terry Gilton (Chair, Advisory Board), (4) industry partnerships will be leveraged for the resourcing of the dairy protein spray-dry pilot lab (Module II), and (5) USDA and private industry will be solicited for the resources to complete the food safety engineering mockup lab (Module III).

Appendix A

Facilities & Equipment

Appendix A contains facility and equipment descriptions in the following order.

- PI McDougal
- Co-PI Warner
- Co-PI Oxford
- Co-PI Lighty
- Co-PI Browning

MCDOUGAL - FACILITIES AND EQUIPMENT

Laboratory: PI McDougal has two wet bench laboratories of 350 ft^2 and 700 ft^2 that are well-equipped for natural products chemistry, peptide synthesis, food and dairy chemistry, and biomass extraction and component separation. In the 350 ft^2 lab there is one four-foot fume hood, an 18 MΩ-cm nanopure water system, two ovens, chest freezer, refrigerator, rotovap, FT-NIR spectrometer, analytical balance, centrifuge, and three computer workstations. In the 700 ft^2 laboratory space, there are three chemical fume hoods, an 18 MΩ-cm nanopure water system, two HPLC systems, peptide synthesizer, chemical microwave, rotovap, lyophilizer, two analytical balances, three computer work stations, and a variety of small equipment. Work in the lab includes: (1) extraction, isolation, and characterization of steroidal alkaloids from the plant or blood/breast milk of poisoning patients from *Veratrum californicum or Veratrum parviflorum*, (2) whey or milk dairy protein content evaluation by MIR, NIR, Kjeldahl, Leco, and LC-MS, (3) cell culture work to assess the bioactivity and matrix biology of a dairy protein for FDA drug approval, (4) reducing sugar, free amino acid, and acrylamide analysis from potatoes and potato blanch water by LC-MS and GC-MS to study the impact of exposure to pulsed electric field treatment or frying, and (5) toxicological studies of patient blood from pong-pong seed poisoning. Students are trained to perform their research in my lab or the Biomolecular Research Center, which is staffed by professional scientists, and has been established as a recharge facility run by Co-PI and Director, Dr. Julie Oxford). Work with area industry involves food and dairy process chemistry, as well as evaluation of science and technology applications in food processing. Quantitative and qualitative analysis of nutraceutical and food (potato, onion, wine, etc.) products are routine activities in the lab. Food chemistry projects include: (1) method development for the determination of protein denaturation in milk using FT-IR, CD, and UV-Vis, (2) determination of inhibitors of propionibacteria in Swiss cheese milk, and (3) quantitative determination of acrylamide content in fried potato products by LC- or GC-MS and NIR.

Clinical: N/A

Animal: N/A

Computer: The McDougal group has resources for computational chemistry that include six computer Windows-based PCs with access to computing clusters (Beowulf, R1, Kestrel, Idaho National Lab). Computational work using the DockoMatic software is performed in collaboration with Dr. Tim Andersen in the Department of Computer Science and Engineering at Boise State University. PI McDougal also has two office computers that he uses whether at home or university office.

Office: PI McDougal has a 200 ft^2 office at the university and a 200 sq^2 home office. As the Department Chair, PI McDougal is located in the administrative office suite for the department. PI McDougal has ready access to an office manager, accountant, and two administrative assistants.

Other: The College of Arts and Sciences at Boise State University has a fully equipped instrumentation and machine shop staffed by a professional fabricator, Mr. Randy Nuxoll. This 1600 sq. ft. facility is used for routine repair of electronics, equipment, instrumentation, and fabrication of items necessary for research and academic usage. The Department of Chemistry and Biochemistry has the premiere NMR facility in Idaho and a robust inventory of chemical instrumentation and equipment. The Biomolecular Research Center is a core facility open to biomedical researchers. The latter two facilities are described below.

DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY NUCLEAR MAGNETIC RESONANCE FACILITY

The NMR facility is located in the Science Building on the campus of Boise State University. Associate Research Professor Joe Dumais, Ph.D. manages the facility, maintains and repairs the instruments, assists with experiments, and trains new users in the proper operation of the instrumentation. The NMR facility houses a Bruker IPSO 300 MHz NMR spectrometer with a BBO probe for routine walkup usage. A second Bruker AVANCE III 600 MHz NMR spectrometer is equipped with liquids (BBO, TXI, and TCI cryoprobe) and solids (4mm MAS) probes, and is dedicated to longer duration experiments for research applications. Between both spectrometers, there is ample access for both academic laboratory and research project activities to be conducted.

Additional departmental instrument assets available for student research include optical spectroscopy (FT-IR, UV-Vis, fluorescence, and Raman), GC, GC-MS, LC-MS, AAS, and ICP-OES. Instrument access is granted following training with stockroom personnel who maintain, repair, and operate the instruments. Once students are trained, they are able to schedule time and independently use the instruments for their research.

BIOMOLECULAR RESEARCH CENTER

The Biomolecular Research Center (BRC) provides an additional 5,195 ft^2 of laboratory and office space for proteomics, histology, microscopy and imaging, shared molecular and biochemical sample preparation and analysis. This NIH R15 AREA proposal describes development of a PC12 cell-based bioactivity assay that has been piloted in the BRC. The BRC is well equipped for cell culture work described in this proposal to be conducted. A comprehensive list of equipment available in the BRC shared-use research center is provided at https://brc.boisestate.edu/. In addition to cell culture, the BRC houses a state-of-the-art mass spectrometry facility that is managed by Dr. Shin Pu. Of the instruments in the mass spectrometry facility, the Bruker Q-TOF Mass Spectrometer is the most applicable and useful to this NIH R15 AREA proposal for confirmation of lead compound identification and purity. The Bruker Q-TOF mass spectrometer is located in room 215 in the Mathematics building on the campus of Boise State University. This system is a hybrid tandem mass spectrometer with outstanding performance including fast acquisition rate (up to 30 Hz for small molecules, up to 5Hz dynamic for peptides), high resolution (50,000 full sensitivity and resolution), high resolution EIC (0.5 – 1 mDa on typical LC peaks), and excellent sensitivity (1 pg Reserpine >100:1 S/N RMS). This mass spectrometer is coupled with a Dionex Ultimate 3000 HPLC system and an innovative captive electrospray source. In combination with software tools, including Bruker Compass Data Analysis, Smartformula, ProteinScape, Mascot protein search engine, and Profile Analysis, this LC-MS system is used in small molecule identification, metabolomics analysis, and protein characterization.

EQUIPMENT

Over the past 15 years at Boise State University, PI McDougal has equipped a robust research environment for undergraduate students to work on projects across topics in terrestrial and marine natural products, food and dairy chemistry, and computational chemistry. The equipment available to students in the McDougal lab is complemented by departmental and university instrumentation and facilities. The instrumentation and equipment in the PI's research labs are detailed below. If this IGEM HERC grant is successful, PI McDougal will populate the food and dairy Modules (I &II) with the equipment from his lab.

Computational Chemistry Assets

- Cluster accounts (Beowulf, R1, R2, Kestrel, Idaho National Lab)
- Six Windows PCs
- A 48 work station student chemistry computer lab

Thermo Fisher Scientific UPLC-DAD-CAD/MS

- LPG-3400SD Pump
- Charged Aerosol Detector (CAD) Corona ultra RS Detector
- Diode Array Detector-3000 (DAD)
- MSQ Plus Mass Spectrometer (MS)
- Chromeleon Software

Thermo Fisher Scientific UPLC-DAD

- LPG-3400SD Pump
- Diode Array Detector-3000
- WPS-3000TRS AutoSampler
- Chromeleon Software
- Fraction collector

Bruker FT-NIR Spectrometer MPA

- Extension module MPA-R (reflectance)
- OPUS Spectroscopy Software
- OPUS/LAB: data acquisition and automated NIR analysis
- OPUS/QUANT: quantitative analysis software
- OPUS/DATABASE: Software package and database for storing and managing spectra.
- B-OIL Method: Multiple Calibration Packages for Edible Oil Industry

Nicolet iS20 FT-MIR Spectrometer

- ATR device
- OMNIC Spectroscopy Software
- Data acquisition and automated MIR analysis
- Quantitative analysis software

CEM MARS 5 Chemical Microwave

- GreenChem Plus mini-Vessel Accessory Set/Teflon
- Solvent Extraction Sensor
- Chemical synthesis vials and turn table

Labconco Lyophilizer

- Centrivap Refrig 115V 60 Hz
- Labconco refrigerated centrifugal concentrator

- Labconco FreeZone Plus Freeze Dry system

C S Bio CS 136XT Automated Peptide Synthesizer

Additional laboratory equipment

- Speedvac
- Two rotary evaporators
- Refrigerator/freezer & chest freezer
- Simple & fractional distillation
- Soxhlet reflux
- Two ultrapure water purification systems (18 MOhm)
- Two Supelco Visiprep SPE Vacuum Manifolds
- Foss KT-200 Kjeltec
- Leco Nitrogen Analyzer

WARNER - FACILITIES AND EQUIPMENT

Laboratory: A modern (Built 2011) laboratory space dedicated to the PI is located on the 2nd floor of the Environmental Research Building (ERB 2108/2110) on the main campus at Boise State University. Consisting of 2 adjoined rooms of approximately 650 sq. ft. each (1,300 sq. ft. total), the space includes twelve-foot benches (6 workspaces), 2 six-foot fume hoods, and 4 sinks with tap, DI, and ultra-pure water. There are areas for electrophoresis, western blot, bacterial culture, protein expression and purification, and dishwashing. This space also contains two refrigerators and freezers (–20˚C and –80˚C) and a chromatography cabinet. The following are a list of equipment relevant to this grant application:
Major Lab Equipment:

- Orbital shaking incubators with heating and refrigeration (3)
- Centrifuges for harvesting cells (2)
- Sonicator
- Wyatt miniDawn TREOS 3-angle MALS
- Wyatt Optilab T-rEX refractive index detector
- BioRad BioLogic low-pressure chromatography system
- GE ÄKTA Pure FPLC
- Chromatography Columns
    - S75 and S200 16/60 Size exclusion chromatography
    - Ion exchange and affinity purification (GST, IMAC, amylose, and others)
- QuantStudio3 qPCR system
- Applied Biosystems SimpliAmp thermocycler
- Nanodrop One spectrophotometer

Computers

The PI has five computer workstations (three Windows-based PCs and two OSX workstations) with access to computing clusters (Beowulf, R1, Kestrel, Idaho National Lab). Two laptops are available for document preparation, data analysis and presentations for students.

Other Facilities: The Biomolecular Research Center is located in an adjacent building and provides an additional 5,195 sq. ft. of laboratory and office space for proteomics, histology, microscopy and imaging, shared molecular and biochemical sample preparation and analysis. These laboratories are outfitted with instrumentation and resources to support the proposed research. Use of this facility is available for all members of the Department of Chemistry.

The NMR Facility is located in the Science Building on the campus of Boise State University. Professor Joe Dumais oversees the facility and assists and trains new users. The facility is equipped with a Bruker IPSO 300 MHz NMR with a BBO probe, and a Bruker AVANCE III 600MHz NMR Spectrometer with liquids (BBO, TXI, and TCI cryoprobe) and solids (4mm MAS) probes.

A scientific instrumentation shop is available, which includes a complete electronics and machine shop for repair of equipment and instrumentation and for fabrication of items necessary for research.

Office: Office space of approximately 150 sq. ft. in the Environmental Building is solely occupied by the PI. Department administrative and grant management support is also available. A shared office space of approximately 200 sq. ft. with 4 desks is dedicated for use by graduate students and post-doctoral associates for the Warner lab.

Computer: Dedicated computers are available in the lab spaces for data storage, analysis, and internet access for pursuit of this project. Additionally, research data is maintained on a shared server with access by all members of the lab and back-up storage with a data storage plan is in place utilizing the Boise State Office of Information Technology, which occupies 38,000 sq. ft. of space in multiple locations on campus to provide academic, administrative and research support to the university. Full time support staff members are available to assist investigators with their computational needs. The Research Computing Department, established by the Division of Research and the Office of Information Technology, centralizes support for cyberinfrastructure computing assets of the University. Research Computing supports advanced data acquisition, storage, management, integration, mining, visualization, and other computing and information processing services, assisting researchers with centralized high-performance computing and related software.

High Performance and Grid Computing: Boise State University has high performance computing clusters for research activity, including the R1 cluster, which is a Linux core operating system (CentOS 5.2) supporting 16 compute nodes, each with 32 AMD Opteron 6128 8 core CPUs, for a total of 256 CPU cores. Five compute nodes with dual T-2050′s GPU cards, and 3 compute nodes with GTX680 GPU cards. Each GPU has 448 cores. The 16 node GPU cluster is physically located at the computing facilities of Idaho National Laboratory (INL) in the Idaho Falls location. KESTREL CPU/GPU cluster is a 32-node CPU/GPU cluster acquired through an NSF MRI grant (NSF Award # 1229709). It is available to researchers at Boise State University including students and graduate students affiliated with a research project.

Additionally, computers and computer support are readily available to all faculty, staff, and students. Typical specifications for individual researchers are a computer with a multi-core processor with 8 GB of RAM, 640 GB disk space, running current Microsoft operating system with dual 24” monitors. Computers are equipped with Microsoft Office products such as Excel, Word and PowerPoint to enable reports and graphs, and network or wireless capability. Additionally, the investigators performing statistical analysis have SPSS statistical analysis software. Printing services for research posters are readily available through academic departments and Campus Graphics Department.

Hardware available includes a high-performance computing cluster, a 16 node GPU cluster physically located at the computing facilities of INL in Idaho Falls. Free storage and servers for research are offered by the Office of Information Technology to researchers and faculty at Boise State University. Virtual servers to support research are based on Cisco UCS Blade Server platforms, VMware ESX platform software, and NetApp SAN storage. This platform is built with redundancy and is auto-correcting. Typically, 1CPU, 1GB memory VM server with either a Microsoft Server or Red Hat operating system is provided, in a managed or unmanaged designation. With a managed server system, administrative services are provided. For servers designated as unmanaged, system administration services are the responsibility of the researcher.

Globus is software-as-a-service for file transfer and sharing. Designed specifically for researchers, Globus provides fast, reliable, and secure file transfer among XSEDE resources or between an XSEDE resource and another machine (such as a campus cluster, lab server, or

personal computer). Globus is core campus bridging technology that enables researchers to scale their computational research from the desktop, across campus, and to national cyberinfrastructure. Beyond file transfer, Globus allows researchers to securely share data with collaborators directly from existing systems, without investing in additional campus or cloud storage just for the purposes of sharing.

University of California Data Management Plan online tool is made available to Boise State researchers to assist in the development of Data Management Plans which are required for NSF and NIH grant applications. Support for use of this tool is provided to researchers by Boise State's Office of Sponsored Programs, Library Data Management Resources through Boise State's Albertsons Library staff, Office of Information Technology Research Computing, Office of Technology Transfer, and the Office of Research Compliance.

Administrative Support: Administrative support for grant preparation and grant management is provided at the department and college level, with additional grant support provided within the BRC. Grant writing seminars and workshops are available to all interested faculty members as they develop their research ideas. One-on-one support is provided from several technical writers for both grant proposal and manuscript development and submission. The Office of Sponsored Programs provides comprehensive support for grant proposal submission, budget development, and post-award management of grant awards. Accounting support is provided at the department, center, and college levels.

Research Environment: Intellectual rapport is fostered at Boise State University through regular seminar series that address topics of interest to multiple groups between the Colleges of Engineering and Arts/Sciences, research networking events that provide an opportunity for biomedical investigators from diverse disciplines to focus on shared interests, and collaborative arrangements that develop as an outcome of the multidisciplinary research culture present at Boise State University. Dr. Warner will hold weekly laboratory meetings with students, postdocs, technicians, collaborators, and staff of the BRC to facilitate communication and progress on the project. In addition, a weekly writing group will support dissemination of research results while at the same time train students and young investigators essential skills.

Institutional investment in the success of the investigators is provided at Boise State University through travel grant programs, continuing training opportunities, organized peer groups that work as grant writing circles and grant writing mentors who provide a "pre-review" of grant applications prior to submission to funding agencies. Training in the responsible conduct of research and biosafety are provided by the University and are required of all researchers.

Scientific Environment: Boise State University is committed to achieving the goal of becoming a metropolitan research university of distinction. Boise State University provides considerable administrative support for researchers. The Office of Sponsored Programs facilitates grants proposal submissions and post-award management. The Office of Research Compliance oversees IACUC, biosafety, and human subject use as well as trains faculty, staff, and students on responsible conduct of research. For assistance with intellectual property, the Office of Technology transfer is available. Additionally, the Environmental Health and Safety Office provides on-line and in-person training for laboratory safety.
An interdisciplinary Ph.D. program in Biomolecular Sciences was launched six years ago that combines curriculum and laboratory experiences from Physics, Chemistry, and Biology. In addition, NIH-funded COBRE ($10 million) and INBRE grants facilitate research and collaborative opportunities. For example, these funding sources provide support for the BRC and funds graduate students on research assistantships. INBRE funding also supports undergraduate

summer fellowships that offer weekly mentoring workshops and the opportunity for students to present research findings at scientific conferences, including the Idaho Conference on Undergraduate Research (ICUR). Consequently, the research environment is strong at Boise State University and positions this project for a high likelihood of success.

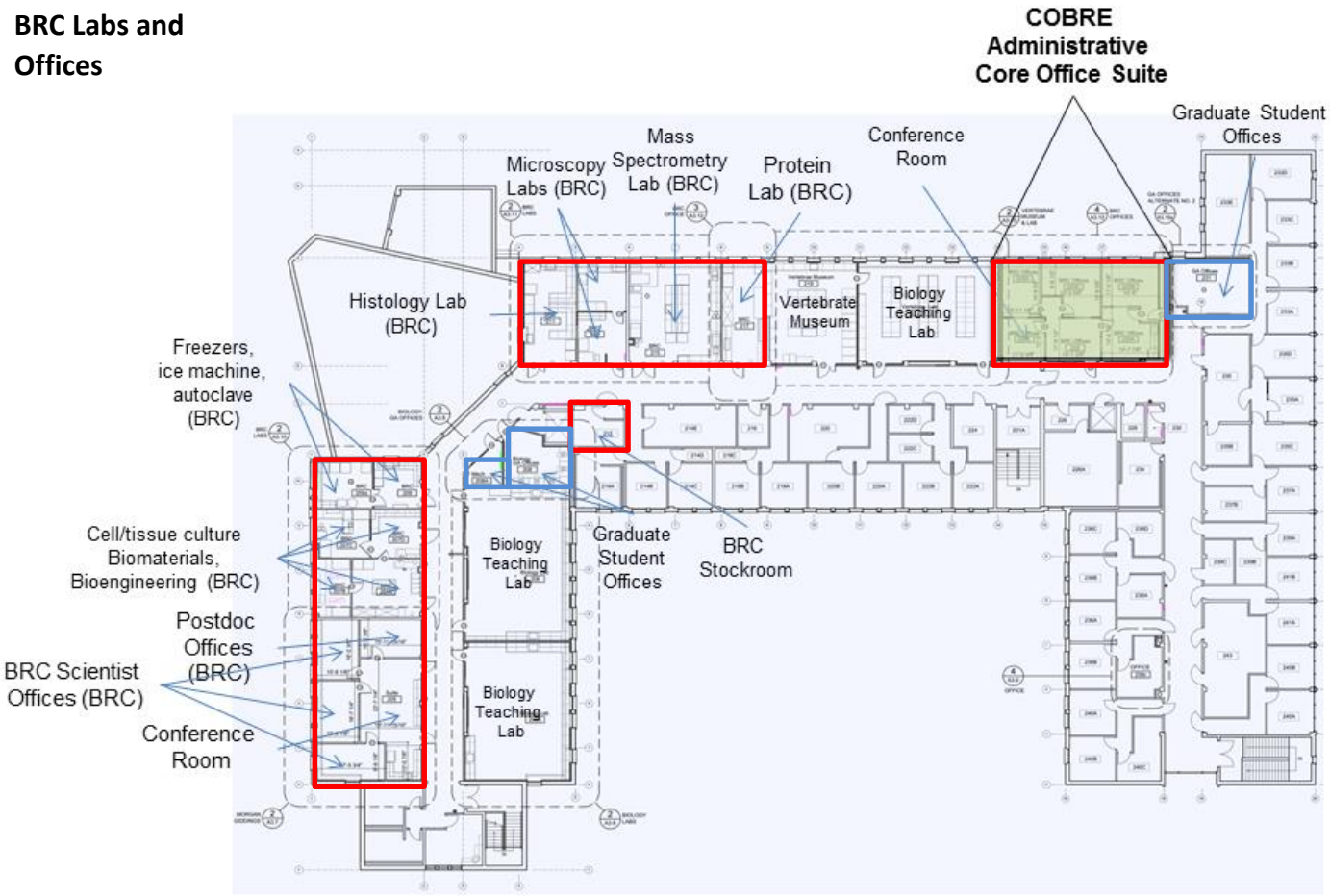
Statement of institutional support for the proposed research project: The Department of Chemistry fully supports and encourages the PI to pursue external research funding. The PI holds a newly appointed (August 2018) tenure-track faculty position in the Department of Chemistry and was provided with start-up funds and a newly renovated laboratory space. New faculty are given lighter teaching loads with options to buy out of classes after the first 2 years. In addition, the PI has utilized resources available at the Biomolecular Research Center to generate the preliminary data included in this application. The department will continue to support the PI in any manner necessary (e.g. appropriate release time and administrative support) to facilitate her ability to carry out the proposed research and maintain a productive and vibrant research program that includes the training and mentoring of students in her laboratory.

OXFORD/BIOMOLECULAR RESEARCH CORE - FACILITIES AND EQUIPMENT

Environment:

The Biomolecular Research Core is located in dedicated laboratory and office space near the office suite of the Administrative Core. The Administrative Core serves as central receiving for purchases made for the BRC and all research scientists of the BRC have mailboxes in room 225 (see floor plan). Graduate student offices are nearby the BRC research labs. Communication between the BRC shared core facility staff and the Administrative Core is facilitated by proximity. BRC research scientists and biostatistician have offices and conference space in rooms 205 and 225. Weekly BRC core meetings are held in the conference room in the 205 office suite. BRC scientists meet with prospective and current users of the core facility in one of the conference rooms in either room 205 or 225 as needed.

BRC Labs and Offices



The Facilities available in the Biomolecular Research Core for the Center of Biomedical Research Excellence in Matrix Biology at Boise State University are ideal for the successful implementation of the center and to support career development of junior investigators. The resources in each of the Research Project Investigators' laboratories are complemented by shared core facilities within the Biomolecular Research Core that are fully available for the projects and supported by full-time professional research staff with expertise in Histology, Proteomics, Cell and Tissue Culture, Microscopy, and *in vitro* analytical assessment of molecular interactions. Communication among team members of the COBRE in Matrix Biology including the research staff of the BRC, is facilitated through weekly Research Grand Rounds.

Laboratory:

In addition to the laboratories of the Research Project Investigators within the College of Arts and Sciences and the College of Engineering, the Biomolecular Research Core also provides an additional ~5,000 sq ft of laboratory and office space for activities and shared instrumentation laboratories to complement individual research laboratories.

Biomolecular Research Core shared facilities. The BRC is comprised of six primary laboratories. The instrumentation and capabilities are presented below.

Molecular Interactions Laboratory: The Jasco J-810 spectropolarimeter consists of a variable wavelength polarimeter and absorption spectrophotometer. It allows secondary structure determination by circular dichroism; specifically measuring the left- and right-handed circularly polarized light of optically active molecules. It is equipped with thermoelectric temperature control. The ProteomeLab/XL-I analytical ultracentrifuge measures the relative change in the distribution of molecular weights, providing an efficient way to measure heterogeneity, stoichiometry, and self-associating systems. It is designed for the in-solution characterization of proteins, oligomers, aggregates, particles, colloids, and small structures and can be used to probe protein size, dimerization, and binding constants. Wyatt Technologies Field Flow Fractionation-Multiangle Light Scattering (FFF-MALS) and Size Exclusion Chromatography-MALS (SEC-MALS) systems are available for determination of molecular mass, size, and shape of molecular complexes.

Spectrophotometers, Surface Plasmon Resonance, Malvern MicroCal PEAQ-ITC, and Fluorescence: The Cary Eclipse Fluorescence Spectrophotometer is available to use for measurements of the emission of light from samples. It can capture data points every 12.5 ms and scan at 24,000 nm/min. The Varian Cary 100 UV-Vis Spectrophotometer (190 nm to ~900 nm) is equipped with a multicell sample transport, a temperature controller, an extended sample compartment, and can be used for concentration and kinetics measurements, and RNA/DNA and protein denaturation and renaturation. The Varian Cary 50 UV/VIS Spectrophotometer has a data collection rate of 80 points per second that can be utilized for kinetics assays. The Reichert SR7000 Surface Plasmon Resonance spectrometer is designed for label-free, real-time detection of nano, micro, and macro molecular interactions. This system has been automated with the addition of a Thermo Finnigan Surveyor Auto Sampler and Pump. Both SPR and Malvern MicroCal PEAQ-ITC can be utilized in applications that include the characterization of molecular interaction of small molecules, proteins, antibodies, nucleic acids, biomolecules and lipids and the assessment of the effect that changes in molecular structure have on binding mechanisms and the associated impact on biological activity.

Molecular and Cellular Imaging Laboratory: The Zeiss Microscope, LSM 510 Meta confocal imaging system is located within the BRC. The Axiovert Observer Z1 inverted microscope has filter sets appropriate for DAPI, FITC and CY3/TRITC to view samples in a conventional widefield microscopy mode as well as the objective lens: 10x, 20x, 40x, 63x and 100x. The LSM Meta 510 is configured with six excitation lasers lines (405, 458, 488, 514, 543 and 633 nm), two photomultipliers, a detector for bright field image acquisition and a polychromatic META detector capable of detecting many standard fluorophores, including DAPI, FITC, CFP, YFP, Rhodamine, TRITC, Cy3, Cy5, Texas Red and many AlexaFluor dyes. Excitation dichroics and emission filters are operated via the LSM software. Added accessories include a heated stage chamber and objective warmer from PECON for live cell experiments and an AxioCam MRm monochrome digital camera. Efforts are underway to increase imaging capabilities.

A two photon laser scanning and confocal microscope is available which utilizes a Spectra Physics Tsunami for two photon excitation, and avalanche photodiode detectors for two photon-counting during two color time resolved fluorescence fluctuation measurements. Data is acquired and analyzed using Enrico Gratton's simFCS software. The microscope is capable of two color Number and Brightness Analysis, Raster Image Correlation Spectroscopy and 3D orbital tracking.

X-ray micro-CT Laboratory: The SkyScan 1172 Micro-CT Scanner has an X-ray source of 20-100V, 10W, <5 µm spot size or 20-80V, 8W, <8 µm spot size, and has a fully distortion-corrected 11Mp X-ray detector that is a 12-bit cooled CCD fiber-optic camera. The detail detectability of the SkyScan 1172 ranges from 0.8/1.0 µm (when operated at the highest resolution) to 25 µm. The SkyScan 1172 currently has two filter choices that can be set into 3 positions to allow for scanning high-density tissues such as bones to low-density softer tissue such as lung. The maximum object size is 50 mm in either diameter or height when scanner is run in offset mode. 2D/3D reconstruction can be performed using a single PC or using the 4-PC cluster in the BRC facility to improve post-scan reconstruction times

Additional microscopes available as shared equipment in the BRC: The Zeiss StemiSV11M2 Bio Quad Fluorescent Microscope combines stereo macro- and compound micro-imaging capabilities. This system combines stereo and high-resolution microscopy in a single microscope for studying fluorescent proteins of GFP, YFP, and BFP. An Olympus BX53 compound microscope with an automated mechanical stage, camera, computer interface, digital display, fine focus, and an oil immersion lens is available. Samples can be viewed by brightfield and phase contrast. Objective magnification from 1.25x to 40X. The Zeiss Axiovert 40CFL is available for transmitted light, Phase contrast, DIC and fluorescence. The 40CFL has a fixed camera port connected to a Zeiss ERc5S digital camera, equipped with 5X, 10X, 20X and 40X objectives and filters for common blue and green fluorescence. The TS100 inverted microscope & SPOT RT3 Camera utilizes a high-intensity LED illumination system. The Olympus BX53-P Polarizing Microscope uses UIS2 infinity-corrected optics providing Nomarski DIC and fluorescence microscopy in addition to polarized light observation. The EVOS Fluorescence microscope is an integrated inverted multichannel LED fluorescent microscope capable of screening slides stained with DAPI, green and red fluorescence along with phase contrast imaging. The EVOS microscope has a manual stage with adapters for slides, multi-well wells, 100mm and 35mm dishes and flasks.

Mass Spectrometry and Proteomics Research Laboratory: The BRC operates a 950 sq ft laboratory dedicated to mass spectrometry and biomolecular interaction analysis. The laboratory provides facilities to isolate proteins and prepare samples for mass spectrometry analysis. The BRC currently has three mass spectrometers; a Bruker Daltonics MaXis Quadrupole Time-of-Flight, a Thermo Scientific Velos Pro Dual-Pressure Linear Ion Trap, and a Matrix Assisted Laser Desorption/Ionization (MALDI) spectrometer. The Bruker Q-TOF Mass Spectrometer is a tandem mass spectrometer with fast acquisition rate (up to 30 Hz for small molecules, up to 5Hz dynamic for peptides), high resolution (50,000 Full Sensitivity and Resolution), high resolution EIC (0.5 – 1mDa on typical LC peaks), and excellent sensitivity (1 pg Reserpine >100:1 S/N RMS). This mass spectrometer is coupled with a Dionex Ultimate 3000 HPLC system and a captive electrospray source. In combination with software tools, including Bruker Compass Data Analysis, SmartFormula, ProteinScape, Mascot protein search engine, and Profile Analysis, we use this LC-MS system in small molecule identification, metabolomics analysis and protein characterization. The Thermo Scientific Velos Pro Linear Ion Trap Mass Spectrometer offers Trap-HCD (Higher-Energy Collisional Dissociation) combined with CID (Collision-Induced Dissociation), and PQD (Pulsed-Q Dissociation) for

proteomic analysis. A nano liquid chromatographic system is coupled to the mass spectrometer through a nanoelectrospray source for protein characterization. In combination with the Thermo Proteome Discoverer 1.3 Sequest and Mascot database search engine, this LC-MS system is used for routine proteomic analysis. In 2016, the BRC added a third mass spectrometer – the MALDI Imaging system and an HTX Imaging TM-Sprayer Tissue MALDI Sample Preparation System that is utilized for MALDI sample preparation and matrix deposition on two-dimensional biological samples. The TM-Sprayer provides heat to the matrix solution to accelerate adsorption into the tissue, as well as a controlled flow of dry air or nitrogen to focus the spray and control drying time.

Histology Laboratory: The histology laboratory within the BRC occupies 600 sq ft and has an additional 250 feet for sample storage. The lab provides paraffin embedment, frozen sectioning, immunohistochemistry, enzyme histochemistry, glycol and methyl methacrylate embedment and staining. The laboratory supervisor, Dr. Cynthia Keller-Peck, and technical staff are trained in the various procedures of paraffin histology and frozen sectioning. The Leica CM1950 cryostat is designed with UVC disinfection to eliminate the need for chemical disinfectant handling and disposal. The Leica Vibratome VT1000 allows for the sectioning of fresh or fixed tissue without freezing or embedding. The StatSpin CytoFuge is used to prepare thin-layer cell preparations. The Leica Autostainer XL processes multiple specimens with 18 reagent vessels, an integrated fan-forced oven, 5 wash vessels, 10 slide racks – each with a capacity for 30 standard slides. This system has 15 programs of up to 25 steps each, and the capability of running multiple programs simultaneously. The Leica TP1020 is an automatic tissue processor. The TP1020 improves the infiltration of tissue with a vacuum and it also minimizes exposure to hazardous fumes with activated carbon filters. The Leica RM2235 Rotary Microtome is available for manual routine paraffin sectioning, but can also be used for cutting harder materials. The Leica EG1150 H is a heated, paraffin dispensing module with 3-liter capacity and a heated work surface with storage areas for both cassettes and molds.

Cell and Tissue Culture Laboratory: The BRC provides 600 sq ft laboratory space for tissue dissection, explant production and maintenance of experimental samples in a controlled environment. Three laminar flow biosafety cabinets and four CO_2 incubators are available. Equipment includes a four vessel Rotating Wall Vessel (RWV) Bioreactor for 3-D cultures. Refrigerators and freezers (-20°C, -86°C, and liquid nitrogen), and centrifuges are available. The Countess® II FL Automated Cell Counter is a benchtop cell assay platform equipped with optics and image analysis software for rapid assessment of cells in suspension. With bright-field and two optional fluorescence channels—researchers can count cells, monitor fluorescent protein expression, and measure cell viability.

The RWV Bioreactor designed by NASA scientists at the Johnson Space Center to culture cells and tissue in a simulated microgravity environment is available in the BRC. The RWV bioreactor consists of a cylindrical vessel that contains a flat silicone rubber gas transfer membrane for oxygenation capable of rotating at a constant angular speed. Rotation of the vessel creates an upward hydrodynamic drag force against the downward gravitational force, producing a microgravity-like culture condition. This system allows for solid body rotation around a horizontal axis, resulting in randomization of the gravitational vector, low shear stress, three-dimensional spatial freedom and oxygenation by diffusion of dissolved gasses from the reactor chamber. During rotation of the vessel containing media and cells seeded on an appropriate 3-D carrier, the cells are exposed to a constant rotation, producing a vector-averaged gravity comparable with that of near-earth free fall orbit. We have used this system with osteochondral tissue explants as well as several chondrocyte cell lines to study the effects of simulated microgravity at the cellular level and to maintain cells in suspension.

The BioFlux Inverted microscope/microfluidic flow chamber is available for analysis of cell interactions under flow. The BioFlux system includes high speed capabilities based on automated experimental control, multiplexing up to 96 simultaneous experiments, and sophisticated data analysis software simplifying and accelerating complex functional assays.

Quantitative real-time Polymerase Chain Reaction. Multiple real-time PCR thermocyclers are available throughout the laboratories within the Department of Biological Sciences and the BRC to support quantitative PCR for expression analysis using a 96-well plate format. ABI, Eppendorf Mastercycler® ep *realplex*, and Roche Light Cycler 96 models are available. Additionally, several endpoint PCR thermocyclers are available.

Gel Electrophoresis, Imaging and Documentation: Both 1D and 2D electrophoresis and electroblotting units from BioRad, Invitrogen and Millipore are available. Several Imaging Systems include the FluorChem R. The FluorChem R Digital Darkroom provides high-performance western blot and gel imaging able to detect chemiluminescent, colorimetric and UV fluorescent gels and blots. The Kodak Imager 4000R imaging system has cooled CCD imaging technology, 4-million pixel resolution, and 16-bit imaging producing 65,000 levels of grayscale resolution for accurate intensity measurement. Detection capabilities include absorbance, chemiluminescence and UV fluorescence imaging. The BioRad Pro Fluorescent Phospho-Imager has 50-µm resolution and a 5 order of magnitude linear dynamic range, is capable of single or multicolor fluorescent scanning, can accommodate large gels and images, and is integrated with PDQuest 2-D Analysis Software. Internal and external lasers allow this unit to perform digital autoradiography by scanning phosphor plates or performing corresponding tissue fluorescence imaging by directly scanning thin tissue sections.

Plate readers and associated equipment: The Synergy Mx is a monochromator-based multi-mode microplate reader with fluorescence, absorbance and luminescence detections modes. The BioTek ELx405R 96-well Plate washer is designed for applications from basic ELISA to cell and bead washing. The Luminex 100 is a compact lab analysis system based on the principles of flow cytometry which enable the simultaneous assay of up to 100 analytes in a single well of a microtiter plate with very small volumes. The BioTek Synergy™ HT Multi-Mode Microplate reader employs a dual optics design for fluorescence, absorbance and luminescence measurements. This system has the ability to use filters with different bandpass filters.

Centrifugation: The Beckman Optima TL Ultracentrifuge includes thermoelectric refrigeration, microprocessor control, smooth acceleration/deceleration profiles, air cooled, imbalance tolerant drive, fast instrument set-up and diagnostic displays. The system can store up to 10 user programs, can reach speeds of 100,000 rpm and can generate a force of 543,000 x g max. The Beckman L8-70M Ultracentrifuge has two rotors available: (1) Type 45 Ti: 6 x 94 mL samples, max speed 45,000 rpm (235,000 x g) or (2) Type 70 Ti: 8 x 39 mL samples, 70,000 rpm (504,000 x g). The Thermo Scientific Sorvall ST 16R refrigerated centrifuge is a general purpose centrifuge used for everyday sample processing, including clinical protocols, cell culture applications and microplate processing. This unit has a 4 x 400ml capacity with a maximum speed/RCF of 15,200rpm/25.830 x g. The Thermo Scientific Sorvall Legend X1R refrigerated centrifuge has a 1L capacity with a maximum speed/RCF of 15,200rpm/25.830 x g; ideal for handling temperature-sensitive sample processing between -10° and +40°C. The Thermo Scientific Sorvall LYNX super-speed refrigerated centrifuge designed to run 24,000 rpm/68,905 xg performance with the maximized capacity of 4 liters for bottles, tubes or microplates.

Chromatography: The Agilent 1200 HPLC available in the laboratory can separate a mixture of

compounds and is used in biochemistry and analytical chemistry to identify, quantify and purify the individual components of a mixture. The HPLC pump is a binary system capable of up to a 10 ml/min flow rate and 400 bar of pressure. The UV-vis detector is a diode array, with a wavelength range from 190 – 950 nm. The fluorescence detector provides simultaneous quantitative and qualitative information for up to four signals simultaneously. The system also incorporates a mobile phase degasser, column heater, and 100 vial autosampler. The BioRad BioLogic™ LP low-pressure chromatography system is used for biomolecule purification. The system includes both 254 nm and 280 nm filters for nucleic acid and protein detection, and a conductivity cell to monitor gradient progress. The BioLogic™ houses a peristaltic pump with a flow rate range of 0.05-40 ml/min and a maximum backpressure of 30 psi. The system is compatible with Econo-Column low pressure chromatography columns and low-pressure chromatography media. Eluent can be collected into eighty 13 x 100 mm tubes or microtubes using a fraction collector. LP Data View software captures data, multitasks, and prints data.

Microinjection, electroporation, genomic editing, and transfection of cells: The Eppendorf InjectMan® NI 2 Micromanipulator has a menu-controlled, programmable micromanipulator; the InjectMan NI 21 is especially suitable for microinjection into adherent cells. The electronic connection of the InjectMan NI 2 and the FemtoJet®2 or FemtoJet express ensures a very rapid and safe microinjection. The Nucleofector™ Device is a single cuvette based system that allows transfection of hard-to-transfect cell lines and primary cells with different substrates (e.g., DNA vectors or siRNA oligonucleotides) in low-throughput format. The Nucleofector™ II/2b Device can also be used for bacteria transformation. The ECM 830 Electroporator is a Square Wave Pulse generator designed for *in vitro* and *in vivo* applications. The versatility of the ECM 830 applications for gene, drug and protein delivery include; mammalian cells, *in vivo, ex vivo* tissue, zebrafish tissue and embryos, nuclear transfer, embryo manipulation, plant protoplast and basic bacteria and yeast transformations. The ECM 830 can be used in combination with a wide array of BTX specialty electrodes and accessories to enhance molecular and drug delivery experiments. The BTX ECM 630 Electroporator is used for gram positive and gram negative bacteria, yeast, fungi and other microorganism transformation in HV mode, and is also optimized for a broad range of mammalian cell lines in LV mode. Applications include yeast, insect cells, bacteria, cDNA libraries, and BAC library.

Flow Cytometry Core Facility: The Flow Cytometry Core Facility (FCCF) is housed in the Science building and will be used for the enrichment of cells in the CRISPR/Cas9 experiments proposed. Dr. Rebecca Hermann, Senior Scientist/Laboratory Manager, is available to assist users of the facility. The FCCF is equipped with a four-laser BD INFLUX cell sorter, supporting four-way sorting, plate sorting for single cell isolation, 9-color analysis, and can operate at up to 200,000 events per second. The BD INFLUX at Boise State is also equipped with a small particle detector allowing particle detection near 200 nm. The BD Biosciences Accuri™ C6 is equipped with a blue and a red laser, two light scatter detectors, and four fluorescence detectors with optical filters optimized for the detection of fluorochromes such as FITC, PE, PerCP, and APC.

Nuclear Magnetic Resonance Facility: The Nuclear Magnetic Resonance Facility is located in the Science Building on the campus of Boise State University. Professor Joe Dumais oversees the facility and assists and trains new users. The facility is equipped with a Bruker IPSO 300 MHz NMR with a BBO probe, and a Bruker AVANCE III 600MHz NMR Spectrometer with liquids (BBO, TXI, and TCI cryoprobe) and solids (4mm MAS) probes.

Tissue Mechanics Laboratory: The Northwest Tissue Mechanics Laboratory (NTML) is located in Boise State's Micron Engineering Center (MEC) and includes 1000 sq ft. The lab is

equipped for research projects in experimental and computational tissue mechanics. The lab is equipped for mechanical testing, culture, molecular biology and data analysis. To facilitate mechanical testing, the laboratory houses an Instron E10000 ElectroPulse biaxial test system. This mechanical test system uses a linear motor to deliver nearly frictionless axial and torsional loads at high frequencies. Multiple load sensors permit sensitive tests that range from small tissue samples to large musculoskeletal structures. Biological test equipment includes a laminar flow fume hood, chemical storage cabinets, and deionized water lines. A workbench is equipped with tools, hardware, materials and electronics to develop and build test fixtures, device prototypes and mechatronic systems. The computing lab is located a few doors down from the wet lab and houses computational resources to perform numerical modeling, molecular dynamics simulations, and computer-aided design. The computers include a quad-core iMac and a quad-core Asus, with Windows and Linux dual-boot. Large numerical problems are run on a high performance computing cluster housing 16 nodes each with 16 cores. This cluster is capable of GPU parallel computing. Finite element software includes LS-DYNA, LS-DYNA PrePost, and FEBio; fluid dynamics software includes OpenFOAM; molecular dynamics software includes vmd, Amber-11, Charmm, Gromacs, and Namd; and computer-aided design is done on SolidWorks.

Computational Biosciences Laboratory (CBL). The CBL is directed by Dr. Clare Fitzpatrick. The primary focus of the CBL is to utilize computational models, typically developed in a dynamic finite element framework, to understand the mechanism of injury, disease or adaptation in biomechanical systems. The CBL has extensive experience in developing sophisticated specimen-specific models, in addition to accounting for uncertainty and population variability through application of statistical and probabilistic methods to deterministic or generic models. CBL is located in Room 402 of the Micron Engineering Building. The CBL is a 500 sq. ft. dedicated computational space equipped with hardware and software to develop, validate and simulate analyses devised in collaboration with experimentalists and clinicians for a holistic experimental and computational approach to biomechanical investigations.

Hardware:

1. Three high performance Linux workstations (HP Z840) with dual-quad core processors
2. Six mid-level HP Z440 workstations
3. Redhawk cluster: 6 node cluster, each node has 4 cores and 32 GB of memory

Software:

- Abaqus (SIMULIA): Abaqus product suite including Abaqus/CAE, Abaqus/Standard and Abaqus/Explicit for finite element solutions for wide modeling capability and customizable ability to address an extremely broad range of physics and multiphysics problems.
- Amira (FEI Visualization Sciences Group): 3D software platform for visualizing, manipulating and understanding data from computed tomography, microscopy, magnetic resonance imaging and many other imaging modalities.
- Hyperworks (Altair): Multi-disciplinary finite element pre-processor which can generate large, complex models and export as ready-to-run solver file. Advanced geometry and meshing capabilities with automatic and semi-automatic shell, tetra, and hexa meshing capabilities.
- Fortran (Intel Composer): Development of Abaqus user-subroutines for a variety of user-defined applications (including constitutive material models, creep, friction, non-uniform distributed loads) to adapt Abaqus to particular analysis requirements.

The High Performance Simulation Laboratory is located in the Micron Engineering Center in the College of Engineering at Boise State University. The Kestrel cluster was acquired with a grant from National Science Foundation's Major Research Instrumentation Program, PD/PI Julia Oxford was Co-PI on this grant. The high performance computing cluster provides the computational power to run large finite element ABAQUS simulations in a parallel computing environment. The system comprises of a tiled display CPU/GPU cluster (8 nodes; head node plus 7 compute-nodes) with Rocks 5.2 operating system. Node configuration consists of Dual NVIDIA GeForce 470 GTX cards, Infiniband SDR interconnection, Intel Core 2 Quad 2.66 GHz CPUs, and 8 GB DDR3 1333 MHz memory.

Computer:

The Office of Information Technology occupies 38,000 square feet of space in multiple locations on campus to provide academic, administrative and research support to the university. Full-time support staff members are available to assist investigators with their computational needs. The Research Computing Department, established by the Division of Research and the Office of Information Technology, centralizes support for cyberinfrastructure computing assets of the University. Research Computing supports advanced data acquisition, storage, management, integration, mining, visualization, and other computing and information processing services, assisting researchers with centralized high-performance computing and related software.

High Performance and Grid Computing: Boise State University has high performance computing clusters for research activity, including the R2 cluster, a heterogeneous compute cluster consisting of 26 nodes and 5 GPU nodes, each with dual Intel Xeon E5-2680 CPUs. The GPU nodes each have dual Nvidia P100 GPUs. A second cluster, Kestrel, is a 32-node CPU/GPU cluster acquired through a National Science Foundation Major Research Instrumentation grant (NSF Award # 1229709). It is available to researchers at Boise State University including students and graduate students affiliated with a research project.

Additionally, computers and computer support are readily available to all faculty, staff, and students. Typical specifications for individual researchers are a computer with a multi-core processor with 8 GB of RAM, 640 GB disk space, running current Microsoft operating system with dual 24" monitors. Computers are equipped with Microsoft Office products such as Excel, Word and PowerPoint to enable reports and graphs, and network or wireless capability. Additionally, the investigators performing statistical analysis have SPSS statistical analysis software. Printing services for research posters are readily available through academic departments and Campus Graphics Department.

Data storage and servers for research are offered by the Office of Information Technology at no cost to researchers and faculty at Boise State University. Virtual servers to support research are based on Cisco UCS Blade Server platforms, VMware ESX platform software, and NetApp SAN storage. This platform is built with redundancy and is auto-correcting. Typically, 1CPU, 1GB memory VM server with either a Microsoft Server or Red Hat operating system is provided, in a managed or unmanaged designation. With a managed server system, administrative services are provided. For servers designated as unmanaged, system administration services are the responsibility of the researcher.

A Data Management Plan online tool is made available to Boise State researchers to assist in the development of Data Management Plans which are required for NIH and NSF grant applications. Support for use of this tool is provided to researchers by Boise State's Office of Sponsored Programs, Boise State's Albertsons Library staff, the Research Computing department, the Office of Technology Transfer, and the Office of Research Compliance.

Software for bioinformatics computing:

Bioinformatics software currently installed on our HPC clusters includes the following:

AMBER-11—Assisted Model Building with Energy Refinement. "Amber" is a set of molecular mechanical force fields for the simulation of biomolecules (which are in the public domain, and are used in a variety of simulation programs); and a package of molecular simulation programs which includes source code and demos.

CHARMM—CHARMM (Chemistry at HARvard Macromolecular Mechanics) is a molecular simulation program with broad application to many-particle systems. It has been developed with a primary focus on the study of molecules of biological interest, including peptides, proteins, prosthetic groups, small molecule ligands, nucleic acids, lipids, and carbohydrates, as they occur in solution, crystals, and membrane environments.

DOCKOMATIC—DockoMatic is a GUI application that is intended to automate the management of AutoDock jobs for high throughput screening of ligand/receptor interactions.

GROMACS—GROMACS is a versatile package to perform molecular dynamics, i.e., simulate the Newtonian equations of motion for systems with hundreds to millions of particles. It is primarily designed for biochemical molecules like proteins, lipids and nucleic acids.

NAMD—NAMD is a parallel molecular dynamics code designed for high-performance simulation of large biomolecular systems. Based on Charm++ parallel objects, NAMD scales to hundreds of processors on high-end parallel platforms and tens of processors on commodity clusters using gigabit ethernet. NAMD uses the molecular graphics program VMD for simulation setup and trajectory analysis, and is file-compatible with AMBER, CHARMM, and X-PLOR.

LAMMPS—LAMMPS (Large-scale Atomic/Molecular Massively Parallel Simulator), is a molecular dynamics (MD) code designed to run on parallel machines, and also on single-processor desktops.

OPENBLAS—OPENBUGS; BUGS is a software package for performing Bayesian inference using Gibbs Sampling. The user specifies a statistical model, of (almost) arbitrary complexity, by stating the relationships between related variables. The software includes an 'expert system' which determines an appropriate MCMC (Markov chain Monte Carlo) scheme (based on the Gibbs sampler) for analyzing the specified model.

R—R is a language and environment for statistical computing and graphics. It is a GNU project that provides a wide variety of statistical (linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering) and graphical techniques.

VASP—The Vienna Ab initio Simulation Package is a computer program for atomic scale materials modeling, e.g., electronic structure calculations and quantum-mechanical molecular dynamics, from first principles.

VMD—VMD is a molecular visualization program for displaying, animating, and analyzing large biomolecular systems using 3-D graphics and built-in scripting.

Licenses for power analysis using nQuery and Xact Maintenance (StatXact and LogXact) software products are available.

Office:

The BRC scientific staff members have offices, ranging in size from 100 to 200 square feet adjacent to the laboratories of the BRC. In addition, Administrative Core offices provide space

for maintaining grant and budget files, personnel files and office supplies. Offices and computers are available to research staff, postdoctoral fellows, research assistants, and graduate students involved with research.

Other resources available at Boise State University:

Machining and Fabrication Shop: The College of Arts and Sciences at Boise State University maintains a fully equipped machining and fabrication shop in the Science building on the main campus for metal working, plastic, welding, and special instrument design. This facility employs a full-time Chief Engineer, machinist/instrument maker. This facility can easily provide any special fixtures needed for our experiments and is fully available for work on this project.

Administrative Support: Administrative support for grant preparation and grant management is provided at the department and college level, with additional grant support provided within the Center. Grant writing seminars and workshops are available to all interested faculty members as they develop their research ideas. One-on-one support is provided from several technical writers for both grant proposal and manuscript development and submission. The Office of Sponsored Programs provides comprehensive support for grant proposal submission, budget development, and post-award management of grant awards. Accounting support is provided at the department, center, and college levels.

Other Facilities and Resources supporting COBRE Activities:

Consortia and Regional Resources.

Regional resources for combined Genomics and Proteomics approaches are available to investigators through partnerships between the Biomolecular Research Core at Boise State and the Molecular Research Core Facility at Idaho State University and the Genomics Resources Core at the University of Idaho. Translational research opportunities are facilitated through collaborative partnerships with the Institute for Translation Health Sciences at the University of Washington and the Clinical and Translational Research Infrastructure Network as a member institution of the Mountain West Research Consortium.

The **ISU Molecular Research Core Facility (MRCF),** with its comprehensive instrumentation and ever-expanding array of services, provides scientists with the resources necessary for successful and productive research pursuits in this rapidly growing field. The MRCF also acts as a center of intellectual exchange and serves to promote collaboration and multidisciplinary approaches to specific research initiatives. Since its establishment in 1994, the MRCF has grown continuously with the aid of significant extramural funding from the NIH and NSF. The MRCF has proven to be of critical importance in the areas of molecular genetics, microbiology, developmental biology, physiology, anatomy, neurobiology, molecular evolution and systematics, phylogenetics, population genetics, bioinformatics, comparative and computational genetics, and pharmaceutical sciences. The MRCF also serves the DNA sequencing and genotyping needs of an increasing number of investigators at other institutions throughout the state and the nation. Routine activities in the MRCF include automated DNA sequencing and microsatellite analysis (Genotyping), PCR, electrophoresis, and gel documentation and analysis.

The **Center of Biomedical Research Excellence (COBRE) for Modeling Complex Interactions (CMCI)** and the **Institute for Bioinformatics and Evolutionary Studies (IBEST)** are interdisciplinary research groups at the University of Idaho. Interdisciplinary collaborations blend the expertise of biologists, biochemists, ecologists, evolutionary biologists, mathematicians, statisticians, and computer scientists to examine the underpinnings of evolutionary biology. Many areas of current biological research rely on high throughput genomic technologies, analysis, and bioinformatics. The IBEST Core Facilities are comprised of the Computational Resources Core, Genomics Resources Core and Optical Imaging Core. The Computational Resources Core contains the most sophisticated and powerful computing resources in the region, and is well-suited to complex computational tasks such as protein modeling, structure/function analysis, and ligand binding studies. In the Genomics Resources Core, researchers will find well-trained staff willing to consult on complex research projects. The Core is well equipped with instrumentation capable of handling DNA sequencing tasks, microarray based experiments, genotyping projects and many other project types.

The **Institute of Translational Health Sciences (ITHS)** is a dynamic organization whose goal is to improve the health for people throughout Washington, Wyoming, Alaska, Montana and Idaho. One of 60 Clinical and Translational Science award sites nationwide, the ITHS is working to change how biomedical research and training is performed. This national consortium is funded by the National Institutes of Health. The ITHS is a partnership between the University of Washington, Fred Hutchinson Cancer Research Center, Seattle Children's Hospital and other regional institutions along with community and tribal groups. The ITHS provides access to training, equipment, pilot funding and clinical study resources to help translate discoveries into practice. Many researchers at Boise State are members of the ITHS.

Boise State University collaborates to develop clinical and translational research through the creation of the **Mountain West Clinical and Translational Research Infrastructure Network.** Boise State supports this project with the specific commitments to serve on the Internal Advisory Committee of the Clinical and Translational Research Infrastructure Network with responsibility to ensure that the network is delivering appropriate services in a timely fashion and that the project is achieving its mission to increase the quantity, quality, and NIH funding of clinical and translational research in the member institutions of the Mountain West Research Consortium.

The Advanced Light Source (ALS) is located in Berkeley, California. The Advanced Light Source (ALS) welcomes researchers from universities, government labs, and industry who are interested in performing experiments at the general sciences and structural biology beamlines. The ALS is a third generation synchrotron light source, providing over 35 beamlines, where samples may be illuminated with x-ray, ultraviolet or infrared light to explore the structure and electronic properties of materials. The ALS operates as a national user facility, and is open to researchers worldwide to submit proposals for research. The ALS does not charge for beam time if the user's research is nonproprietary, i.e., the results are published in the open literature.

The Oregon State University Nuclear Magnetic Resonance (NMR) Facility is available to support the work proposed here. Located on the first floor of the Linus Pauling Science Center, NMR spectrometers available include 800 MHz, 700 MHz, 500 MHz and 400 MHz (2), corresponding to magnetic field strengths ranging from 18.8 T to 9.4 T. Data processing and analysis software is available on workstations in the NMR Facility.

The **OHSU Proteomics Shared Resource facility** was established to make state-of-the-art mass spectrometry based protein analysis analytical capabilities available to the biomedical research community. The facility is available to researchers of the COBRE in Matrix Biology.

Services provided include protein identification / partial sequencing, identification and localization of post-translational modifications, quantitative comparison of protein abundances in complex mixtures using 10-plex TMT labeling, identification of protein/protein interactions by analysis of affinity purified complexes, targeted MRM analysis on known proteins, and determination of whole protein mass. This shared resource facility will be used in the case where mass spectrometry capabilities require additional expertise than that available at Boise State University.

LIGHTY - FACILITIES AND EQUIPMENT

A techno-economic analysis of food processing operations can inform decision making during the assessment of the various techniques under study in this proposed project. The team will use a comparative technique, with a baseline estimate of typical food processing unit operations (e.g., heat exchangers, reactors, separators, vessels, and pumps) and operating costs (chemical costs, water requirements, and energy requirements). This baseline is not meant to be the actual cost of plant operations. The different scenarios will be compared in terms of operating costs as well as capital costs (e.g., equipment size changes, additional equipment needed) needed for system integration. While there are many such studies conducted by others for the chemical and petroleum industry, we have illustrated this methodology for a chemical looping process for the combustion of solid fuels (see Lighty Biosketch).

ProSim+ has been chosen as the simulation software for this analysis since this study may require process units which are not readily available from an existing library. ProSim+ allows the user to develop and enter specialized equipment when needed. In addition, based on the fundamental chemistry and transport (heat, mass, fluids) understanding developed, the software allows for global rate equations to provide important time dependent, and, hence, equipment size, considerations. It also provides solutions for equipment sizing as well as heat and mass balances. This flexibility will allow us to create a robust process flow sheet.

In addition, with feedback from the technical advisory board, more accurate operating and capital costs will be obtained. Specifically, we will report details on the actual process as well as costs for chemicals, water, energy, and equipment. This will allow the simulation to represent more closely an actual plant versus the comparative analysis mentioned above.

BROWNING - FACILITIES AND EQUIPMENT

The Plasma and Vacuum Electron Devices lab consists of 950 sq. ft. of space in a single room. The lab is facilitated with a pump exhaust system, a laminar flow hood, and gas delivery systems. The lab has three high vacuum chamber tests systems. A long working distance (8") microscope with camera capabilities is available for imaging the biofilm during plasma treatment. The lab contains numerous high voltage power supplies (up to 25 kV), signal generators, RF amplifiers, oscilloscopes, a spectrum analyzer, and a network analyzer. The lab also has several high voltage (<5 kV), low frequency (500 Hz-50 kHz) transformers as well as a plasma source AC voltage supply which operates from 20-60 kHz and 0-10 kV. A ne AC power supply is requested for this grant to drive the large CAP-Array. A recently acquired Gas Detector (IS Model MX6) is available along with various gas sources including nitrogen, oxygen, and argon. Three different data acquisition systems are available in the lab. A National Instruments Data Acquisition and Control system is available for use on the experiment. Two CAP research systems are available including one with an XY-stage enclosed in a box to allow for gas venting and a second system also in a vented enclosure. Compressed air, argon, nitrogen, and oxygen are available in the lab for CAP testing. One computer system is dedicated to the National Instruments data acquisition hardware for this experiment. No new data acquisition equipment will be needed for this project. The lab also has a substantial tool set including drills, saws, and punches. The PI has an office within 100 ft. of the laboratory with two computer systems including one designated for simulations requiring intensive CPU time and large memory.

Equipment

The device fabrication equipment is contained in the Ceramic MEMS laboratory, and the test equipment for the device operation is contained in the Plasma and Vacuum Electron Devices laboratory. Both laboratories are located in the Micron Engineering Center. The biological sample preparation and assay capabilities are contained in several facilities in the Math and Science Buildings.

Plasma Array Test Systems: This project will require 2 test systems that are currently available in the PI's Plasma and Vacuum Electronic Devices laboratory. The systems use an AC (8 kV, 20 kHz) power supply, but this supply cannot provide the required power for the large CAP-Array. A new power supply (PVM2000) will be purchased. These setups will be used for the array testing. One configuration consists of an XY-stage enclosed in a box for exhaust purposes. This stage will be used to mimic the robot in early experiments. The test sample will be moved under that plasma array by the XY stage. A mass flow controller is used to measure the air flow rate into the array. An Agilent DSO5014A oscilloscope will be used to measure the AC voltage and current transformer signals. Additional supporting equipment includes a National Instruments (NI) PXI-1033 crate and a NI PXI-6229 data acquisition system with the needed computer to operate the system. This system will control the plasma array operation including the AC and DC power supplies, the gas flow controllers, and the positioning stage.

LTCC Fabrication: This project will require the fabrication of Low Temperature Co-Fired Ceramic devices, which is currently available in the Ceramic MEMS laboratory. All the fabrication equipment required for this project is available including a Lindberg box furnace, an nScrypt direct write system, an MPM speedline screen printer, a PHI uniaxial laminator and a KEKO isostatic laminator, a 30W Universal LASER router, and a Bungard PCB milling machine.

Molecular, Biochemical, and Cellular Research: Equipment available in the Cornell lab for this project includes benchtop biocontainment centrifuges, microfuges, BSL-II biosafety hoods, water baths, heat blocks, vertical and horizontal gel electrophoresis equipment, blotting equipment, power supplies, microwave, refrigerators, freezers (-20, -80, liq N_2), Protein Simple FluorChemE gel/blot imager, balances, pH meters, sonicators and homogenizers, BioLogic chromatography system, light and inverted microscopes, EVOS fluorescence microscope, Eppendorf real-time PCR thermocycler, CO_2 incubators, static and shaking incubators, and a water purification system. A third plasma test setup is also available in this lab. This system can be configured with the CAP-Array and will be used to treat pathogens (bacterial and viral) under BSL2 conditions.

Other equipment and facilities to measure biofilm and viral effects by the plasma device are found in the Biomolecular Research Center, and Depts. of Biological Sciences and Chemistry & Biochemistry in common use facilities that have been established with aid from the Idaho State Board of Education, Murdock Charitable Trust, and NSF Major Research Infrastructure and CRIF grants. These resources comprise approximately 4000 ft^2 total and are located on four floors of the Science building and the Mathematics Building at Boise State University.

Spectrometry: A newly created 750 ft^2 center in the Dept. of Chemistry & Biochemistry houses a 600MHz NMR and EPR spectrometers, and is maintained by a full-time NMR facility manager. A Bruker MaXis UHR TOF mass spectrometer outfitted with a Dionex UPLC and MALDI AutoFlex are operated on a fee-for-service basis and maintained by a full-time mass spectrometry facility manager within the Biomolecular Research Center. Additional common-use analytical facilities include UV/Vis spectrophotometers, stopped flow fluorimeter, FT-IR, Flame AA, Thermo GC/MS, GC, HPLC with diode array and fluorescence detector, and Bruker HCT ETD ion trap MS.

Confocal Microscopy and Imaging facilities: The Biomolecular Research Center provides essential equipment for histology and fluorescence microscopy, including dedicated space for sample preparation and examination by confocal microscopy (Zeiss LSM 5 Pascal scope). The confocal microscope will be used to measure the biofilms and the etch patterns of the plasma scalpel. The confocal microscopy center is run on a fee for service basis and managed by a full time technician. In addition, a 600 ft^2 histology core center containing tissue processors, cryostats, and automated slide staining is managed by a part-time Ph.D. level scientist in the BRC, with access and services available on a fee-for-service basis. Scanning probe microscopy and Electron Microscopy facilities are available through the Dept. of Materials Sciences at BSU (Veeco Nanoscope IV Scanning Probe Microscope).

Student training: One aspects of the project is the inclusion and training of undergraduates. The Biomolecular Research Center and CMEMs laboratory offer one-on-one training for students on instruments required for this project, as well as workshops to train groups of students in the operation and maintenance of instruments, and data analysis and figure preparation. The Plasma Lab offers training on plasma equipment and data acquisition systems, The COBRE in Matrix Biology (BRC) offers instrument training grants for students, and summer fellowships for students with instrument intensive projects.

Vertically Integrated Projects (VIP): Boise State University has implemented the VIP course model in which students across disciplines join research teams early in their careers and work with faculty and graduate students to develop research interests and skills. The project consists of courses for which students receive credit toward their degree. For example, the students take our course in the fall for 1 credit and our course in the spring for 2 credits to receive 3 total credits for the academic year. Students may then take these courses over 2 to 3 years to receive credit for their degree. In engineering these credits meet requirements for technical electives or for Senior Design research while in chemistry and biology, these credits meet research requirements. The goal behind the VIP is that students learn about research, training to use equipment, experimental procedures, data taking, data analysis, the project research topic, keeping a lab notebook, reading journal articles, giving presentations, presenting research posters, and teamwork. **VIP will be an integral part of our Workforce Development providing a highly transdisciplinary educational experience in food processing and food systems engineering.**

Our Plasma Medicine/Agriculture research group has offered such a class since the Fall of 2015. A series of courses in VIP, Mechanical Engineering, Chemistry, and Biology were initiated under the heading: **VIP: Plasma Medicine and Agriculture**. The goal of the project is to study the effects of plasma on a number of plasma/food microbiology related topics including biofilms. Students in the course included electrical, mechanical, biology, health science, and chemistry undergraduate and graduate students. The students included a mixture of sophomores, juniors, and seniors. The students work with the faculty and returning students on the training and research. This course meets weekly throughout the academic year. Students and all faculty attended the course periods to discuss research activities, presentations, and reports. Students from all disciplines work with the faculty from the different disciplines on a weekly basis. Shown in Fig. 1 are two engineering students working on the VIP research. Hence, students from biology have access, mentoring, and training from engineering faculty on the project. Students are required to present their results in poster sessions at the Boise State Undergraduate Research Conference. To date, more than 50 students have participated in our VIP course with many going to graduate school or medical school.

Figure 1. Engineering students work on the VIP:Plasma Medicine and Agriculture project.

The VIP program will continue in parallel with our research project. Students who have the interest will be able to join various research groups directly and continue their research activities both during the academic year and over the summer with funding coming from this proposed project. Hence, the VIP and Research Groups are very closely linked such that interested and motivated students can join the research group after their sophomore year while still attending the VIP class for credit.

This effort will expand under this program with faculty and researchers starting a variety of Plasma Agriculture/Food Processing VIP courses. Each course can be set up to work with Idaho industry partners who can provide research/development ideas, funding, and mentoring. The students can then work with the industry sponsors and position themselves for internships and graduate school in their perspective fields.

Appendix B

Biographical Sketches

Two page biographical sketches are provided for team members in the following order.

- PI McDougal
- Co-PI Warner
- Co-PI Oxford
- Co-PI Lighty
- Co-PI Browning

OWEN M. MCDOUGAL, Ph.D.

Professor & Chair, Department of Chemistry & Biochemistry
Boise State University, 1910 University Dr., Boise ID, 83725
Tel: W (208) 426-3964; Cell (208) 982-0629; Fax (208) 426-1311

Professional Preparation

INSTITUTION	LOCATION	MAJOR	DEGREE & YEAR
SUNY Morrisville	Morrisville, NY	Chemistry	A.S., 1990
SUNY Oswego	Oswego, NY	Chemistry	B.S., 1992
University of Utah	Salt Lake City, UT	Chemistry	Ph.D., 1998

APPOINTMENTS

PERIOD	APPOINTMENT	INSTITUTION & LOCATION
2018-present	Board Member	Western Dairy Center, Logan, Ut
2016-present	Chair, Dept. Chem. & Biochemistry	Boise State University, Boise ID
2015-2016	Assoc. Chair, Chem. & Biochem.	Boise State University, Boise ID
2014 –present	Professor, Dept. Chem. & Biochem.	Boise State University, Boise ID
2013 – 2014	Visiting Prof., Chemistry Dept.	University of Otago, Dunedin NZ
2013 –present	Founding Editor in Chief	AIMS Molecular Science Journal
2009-2011	Faculty Senate President	Boise State University, Boise ID
2009 – 2014	Assoc. Prof., Chem. & Biochem.	Boise State University, Boise ID
2006 – 2009	Assist. Prof., Chem. & Biochem.	Boise State University, Boise ID
2002 – 2006	Assoc. Prof., Chemistry Department	Southern Oregon Univ., Ashland OR
2005	Visiting Instructor, Chem.	University of Utah, SLC UT
2002 & 2003	Visiting Instructor, Chem.	University of Oregon, Eugene OR
1998 – 2002	Assistant Prof., Chem. Department	Southern Oregon Univ., Ashland OR
2001	Visiting Instructor, Chem.	University of Utah, SLC UT

PRODUCTS (* indicates undergraduate student, ** indicates graduate student)

Five Publications Most Closely Related to the Proposed Project:

1) Maranda S. Cantrell[**] and **Owen M. McDougal**, *Compr. Rev. Food Sci. Food Saf.*, "Biomedical Rationale for Acrylamide Regulation and Methods of Detection." https://doi.org/10.1111/1541-4337.12696 (2021).
2) Maranda S. Cantrell,[**] Jared T. Seale,[*] Sergio A. Arispe, **Owen M. McDougal**, *Foods*, "Determination of Organosulfides from Onion Oil." ***9***(*7*), 884; https://doi.org/10.3390/foods907884 (2020).
3) Leanna A. Marquart,[**] Matthew W. Turner,[**] Lisa R. Warner, Matthew D. King, James R. Groome, **Owen M. McDougal**,[*] *Marine Drugs*, "Structure and Bioactivity of KTM, A Computationally Designed Nicotinic Acetylcholine Receptor Antagonist Inspired by α-Conotoxin MII." ***17***, 669; doi:10.3390/md17120669 (2019).
4) Leanna A. Marquart,[**] Matthew W. Turner,[**] **Owen M. McDougal**, *Toxins*, "Qualitative Assay to Detect Dopamine Release by Ligand Action on Nicotinic Acetylcholine Receptors." ***11***, 682; doi:10.3390/toxins11120682 (2019).

5) Matthew W. Turner,[**] Meagan Rossi,[*] Vannessa D. Campfield,[*] John French,[*] Ellie Hunt,[*] Emily Wade,[*] **Owen M. McDougal**, *Fitoterapia*, "Steroidal Alkaloid Variation in *Veratrum californicum* as Determined by Modern Methods of Analytical Analysis." ***137***, DOI: https://doi.org/10.1016/j.fitote.2019.104281 (2019).

Five Other Significant Publications:

1) Julia Thom Oxford, Ken A. Cornell, Jared J. Romero, Diane B. Smith, Tracy L. Yarnell, Rhiannon M. Wood, Cheryl L. Jorcyk, Trevor J. Lujan, Allan R. Albig, Kristen A. Mitchell, **Owen M. McDougal**, Daniel Fologea, David Estrada, Juliette K. Tinker, Rajesh Nagarajan, Don L. Warner, Troy T. Rohn, Jim Browning, Richard S. Beard Jr., Lisa R. Warner, Brad E. Morrison, Clare K. Fitzpatrick, Gunes Uzer, Laura Bond, Stephanie M. Frahs, Cynthia Keller Peck, Xinzhu Pu, Luke G. Woodbury, Matthew W. Turner, *IJMS*, "Center of Biomedical Research Excellence in Matrix Biology: Building Research Infrastructure, Supporting Young Researchers, and Fostering Collaboration." ***21***, 2141; doi:10.3390/ijms21062141 (2020).
2) **Owen M. McDougal**, Peter Heenan, Nigel Perry, John van Klink, *NZJ Botany*, "Chemotaxonomy of kōwhai: leaf and seed flavonoids of New Zealand *Sophora* species." DOI: https://doi.org/10.1080/0028825X.2018.1472107 (2018).
3) Narasimharao Kondamudi, Jacob K. Smith,[*] and **Owen M. McDougal**, *Amer. J. Potato Res.*, "Determination of Glycoalkaloids in Potatoes and Potato Products by Microwave Assisted Extraction." ***94***(*2*), 153-158 (2017).
4) Mehruba Anwar,[**] Matthew W. Turner,[**] Natalija Farrell, Wendy B. Zomlefer, **Owen M. McDougal**, Brent W. Morgan,[*] *Clin. Toxicol.*, "Hikers Poisoned: Identification of Alkaloids in Foraged *Veratrum parviflorum*." DOI: https://doi.org/10.1080/15563650.2018.1442007 (2018).
5) Decha Pinkaew,[**] Abhijnan Chattopadhyay,[**] Matthew D. King, Preedakorn Chunhacha, Zhihe Liu, Heather Stevenson, Yanjie Chen, Patuma Sinthujaroen, **Owen McDougal**, and Ken Fujise, *Nature Comm.*, "Fortilin Binds IRE1α and Prevents ER Stress from Signaling Apoptotic Cell Death." ***8***(*18*), DOI: https://www.nature.com/articles/s41467-017-00029-1 (2017).

SYNERGISTIC ACTIVITIES

Research: Dr. McDougal has served as a mentor to 24 undergraduate students from Southern Oregon University (1998-2006) and well over 60 undergraduates, 6 Master's, 4 Ph.D., 4 technicians, and 4 postdoctoral researchers from Boise State University (2006-present). His lab investigates marine and terrestrial natural products, with an emphasis on food and dairy research.

Public-private partnerships: 2021 – IGEM Commerce grant with Food Physics Group to create the world's best potato chip; 2021 – BUILD Dairy grant to investigate bioactive proteins from milk in collaboration with High Desert Milk, Hyacinth Proteins, and Lactea Therapeutics; 2020 – National Dairy Council (NDC) proposal to study whey protein powders by optical spectroscopy; 2019 – BUILD Dairy grant sponsored by Agropur that led to the NDC grant; 2018 - BUILD Dairy grant sponsored by Gossner Foods Inc. to study Swiss cheese; 2018 – ISDA SCBG acrylamide in fried potato products in consultation with J. R. Simplot Co.; 2018 – BUILD Dairy grant to study protein powders with Agropur.

NSF BIOGRAPHICAL SKETCH

NAME: Warner, Lisa R.

POSITION TITLE & INSTITUTION: Assistant Professor, Boise State University

(a) PROFESSIONAL PREPARATION

INSTITUTION	LOCATION	MAJOR / AREA OF STUDY	DEGREE (if applicable)	YEAR YYYY
Boise State University	Boise, Idaho	Chemistry	BS	2002
University of Colorado, Boulder	Boulder, CO	Chemistry and Biochemistry	PHD	2011
Technical University of Munich	Garching bei München	EMBO ALTF: Structural Biology	Postdoctoral Fellow	2012 - 2014
National Renewable Energy Laboratory	Golden, CO	Analytical Biochemistry	Postdoctoral Fellow	2014 - 2015

(b) APPOINTMENTS

2018 - present Assistant Professor, Boise State University
2015 - 2018 Assistant Research Professor, Boise State University
2014 - 2015 Postdoctoral Researcher, National Renewable Energy Laboratory
2012 - 2014 Postdoctoral Research, Techniche Universität München, Munich
2006 - 2007 Graduate Teaching Assistant, University of Colorado, Boulder, Boulder, CO
2003 - 2006 Research Associate, Boise State University, Boise, ID
2002 - 2003 Staff Scientist, Sapidyne Instruments Inc, Boise, ID

(c) PRODUCTS

Products Most Closely Related to the Proposed Project

1. Pabis M, Popowicz GM, Stehle R, Fernández-Ramos D, Asami S, Warner L, García-Mauriño SM, Schlundt A, Martínez-Chantar ML, Díaz-Moreno I, Sattler M. HuR biological function involves RRM3-mediated dimerization and RNA binding by all three RRMs. Nucleic Acids Res. 2019 Jan 25;47(2):1011-1029. PubMed Central PMCID: PMC6344896.
2. Warner LR, Gatzeva-Topalova PZ, Doerner PA, Pardi A, Sousa MC. Flexibility in the Periplasmic Domain of BamA Is Important for Function. Structure. 2017 Jan 3;25(1):94-106. PubMed Central PMCID: PMC5235167.
3. Xiong W, Lin PP, Magnusson L, Warner L, Liao JC, Maness PC, Chou KJ. CO2-fixing one-carbon metabolism in a cellulose-degrading bacterium Clostridium thermocellum. Proc Natl Acad Sci U S A. 2016 Nov 15;113(46):13180-13185. PubMed Central PMCID: PMC5135332.
4. Warner LR, Varga K, Lange OF, Baker SL, Baker D, Sousa MC, Pardi A. Structure of the BamC two-domain protein obtained by Rosetta with a limited NMR data set. J Mol Biol. 2011 Aug 5;411(1):83-95. PubMed Central PMCID: PMC3182476.
5. Gatzeva-Topalova PZ, Warner LR, Pardi A, Sousa MC. Structure and flexibility of the complete periplasmic domain of BamA: the protein insertion machine of the outer membrane. Structure. 2010 Nov 10;18(11):1492-501. PubMed Central PMCID: PMC2991101.

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

1. Schilling F, Warner LR, Gershenzon NI, Skinner TE, Sattler M, Glaser SJ. Next-generation heteronuclear decoupling for high-field biomolecular NMR spectroscopy. Angew Chem Int Ed Engl. 2014 Apr 22;53(17):4475-9. PubMed PMID: 24623579.
2. Voith von Voithenberg L, Sánchez-Rico C, Kang HS, Madl T, Zanier K, Barth A, Warner LR, Sattler M, Lamb DC. Recognition of the 3' splice site RNA by the U2AF heterodimer involves a dynamic population shift. Proc Natl Acad Sci U S A. 2016 Nov 15;113(46):E7169-E7175. PubMed Central PMCID: PMC5135374.
3. Sánchez-Rico C, Voith von Voithenberg L, Warner L, Lamb DC, Sattler M. Effects of Fluorophore Attachment on Protein Conformation and Dynamics Studied by spFRET and NMR Spectroscopy. Chemistry. 2017 Oct 12;23(57):14267-14277. PubMed Central PMCID: PMC5862035.
4. Hennig J, Warner LR, Simon B, Geerlof A, Mackereth CD, Sattler M. Structural Analysis of Protein-RNA Complexes in Solution Using NMR Paramagnetic Relaxation Enhancements. Methods Enzymol. 2015;558:333-362. PubMed PMID: 26068746.
5. Huang JR, Warner LR, Sanchez C, Gabel F, Madl T, Mackereth CD, Sattler M, Blackledge M. Transient electrostatic interactions dominate the conformational equilibrium sampled by multidomain splicing factor U2AF65: a combined NMR and SAXS study. J Am Chem Soc. 2014 May 14;136(19):7068-76. PubMed PMID: 24734879.

(d) SYNERGISTIC ACTIVITIES

1. Associate Faculty Member of Faculty Opinions (formerly F1000) (2012 - current)
2. Served as NSF Peer Reviewer (2019)
3. Developed and organized a community focused workshop on the Chemistry of Color in Art (2019)
4. Chair of Chemistry and Biochemistry Section of AAAS Pacific Division (2020 - current)
5. Member of Boise State's Internal Biosafety Committee (2020 - current)

NSF BIOGRAPHICAL SKETCH

NAME: OXFORD, JULIA THOM

NSF ID: 000432689@nsf.gov
ORCID: 0000-0002-4850-3569

POSITION TITLE & INSTITUTION: Associate Chair, Department of Biological Sciences

(a) PROFESSIONAL PREPARATION

INSTITUTION	LOCATION	MAJOR / AREA OF STUDY	DEGREE (if applicable)	YEAR YYYY
Linfield College	McMinnville, OR	Chemistry & Biology	BA	1981
Washington State	Pullman, WA	Biochemistry/Biophysics	PHD	1986
ISREC	Lausanne, Switzerland	Chromatin structure	Postdoctoral Fellow	1987 - 1988
OHSU	Portland, OR	ECM, Skeletal Devel	Postdoctoral Fellow	1988 - 1992

(b) APPOINTMENTS

2014 - present Associate Chair, Department of Biological Sciences, Boise State University
2014 - present Program Director, Center of Research Excellence, Boise, ID
2011 - present University Distinguished & Full Professor, Boise State University, Boise, ID
2003 - present Director, Biomolecular Research Center, Boise, ID
2003 - 2009 Associate Professor, Department of Biological Sciences & Graduate Faculty, Boise State University, Boise, ID
1996 - 1998 Visiting Assistant Professor, Clinical Sciences, Colorado State University, Ft Collins, CO
1995 - 2000 Research Assistant Professor, Biochemistry & Molecular Biology and Oral Molecular Biology, OHSU, Portland, OR
1992 - 1995 Senior Research Associate, Shriners Hospital for Children, Portland, OR

(c) PRODUCTS

Products Most Closely Related to the Proposed Project

1. Oxford JT, Cornell KA, Romero JJ, Smith DB, Yarnell TL, Wood RM, Jorcyk CL, Lujan TJ, Albig AR, Mitchell KA, McDougal OM, Fologea D, Estrada D, Tinker JK, Nagarajan R, Warner DL, Rohn TT, Browning J, Beard RS Jr, Warner LR, Morrison BE, Fitzpatrick CK, Uzer G, Bond L, Frahs SM, Keller-Peck C, Pu X, Woodbury LG, Turner MW. Center of Biomedical Research Excellence in Matrix Biology: Building Research Infrastructure, Supporting Young Researchers, and Fostering Collaboration. Int J Mol Sci. 2020 Mar 20;21(6) PubMed Central PMCID: PMC7139617.
2. Oxford JT, Jorcyk CL. Students engage in primary literature in molecular biology techniques using an online journal club format. Biochem Mol Biol Educ. 2020 Nov;48(6):675-677. PubMed Central PMCID: PMC7722140.
3. Bas G, Loisate S, Hudon SF, Woods K, Hayden EJ, Pu X, Beard R, Oxford JT, Uzer G. Low Intensity Vibrations Augment Mesenchymal Stem Cell Proliferation and Differentiation Capacity during in vitro Expansion. Sci Rep. 2020 Jun 10;10(1):9369. PubMed Central PMCID: PMC7286897.

4. Thompson M, Woods K, Newberg J, Oxford JT, Uzer G. Low-intensity vibration restores nuclear YAP levels and acute YAP nuclear shuttling in mesenchymal stem cells subjected to simulated microgravity. NPJ Microgravity. 2020 Dec 1;6(1):35. PubMed Central PMCID: PMC7708987.
5. Hardy MJ, Reeck JC, Fang M, Adams JS, Oxford JT. *Col11a1a* Expression Is Required for Zebrafish Development. J Dev Biol. 2020 Aug 28;8(3) PubMed Central PMCID: PMC7558312.

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

1. Beard RS Jr, Hoettels BA, Meegan JE, Wertz TS, Cha BJ, Yang X, Oxford JT, Wu MH, Yuan SY. AKT2 maintains brain endothelial claudin-5 expression and selective activation of IR/AKT2/FOXO1-signaling reverses barrier dysfunction. J Cereb Blood Flow Metab. 2020 Feb;40(2):374-391. PubMed Central PMCID: PMC7370624.
2. Mellor LF, Nordberg RC, Huebner P, Mohiti-Asli M, Taylor MA, Efird W, Oxford JT, Spang JT, Shirwaiker RA, Loboa EG. Investigation of multiphasic 3D-bioplotted scaffolds for site-specific chondrogenic and osteogenic differentiation of human adipose-derived stem cells for osteochondral tissue engineering applications. J Biomed Mater Res B Appl Biomater. 2020 Jul;108(5):2017-2030. PubMed Central PMCID: PMC7217039.
3. Frahs SM, Reeck JC, Yocham KM, Frederiksen A, Fujimoto K, Scott CM, Beard RS Jr, Brown RJ, Lujan TJ, Solov'yov IA, Estrada D, Oxford JT. Prechondrogenic ATDC5 Cell Attachment and Differentiation on Graphene Foam; Modulation by Surface Functionalization with Fibronectin. ACS Appl Mater Interfaces. 2019 Nov 13;11(45):41906-41924. PubMed Central PMCID: PMC6858527.
4. Gorski JP, Franz NT, Pernoud D, Keightley A, Eyre DR, Oxford JT. A repeated triple lysine motif anchors complexes containing bone sialoprotein and the type XI collagen A1 chain involved in bone mineralization. J Biol Chem. 2021 Feb 18; PubMed PMID: 33610546.
5. Frahs SM, Oxford JT, Neumann EE, Brown RJ, Keller-Peck CR, Pu X, Lujan TJ. Extracellular Matrix Expression and Production in Fibroblast-Collagen Gels: Towards an In Vitro Model for Ligament Wound Healing. Ann Biomed Eng. 2018 Nov;46(11):1882-1895. PubMed Central PMCID: PMC6338431.

(d) SYNERGISTIC ACTIVITIES

1. Associate Chair of the Department of Biological Sciences—I work with faculty and staff to address the teaching and research mission of the department and work closely with the Undergraduate Curriculum Committee.
2. Director of the Biomolecular Research Center at Boise State University—I work with faculty and staff to foster collaboration, provide access to shared research instrumentation, mentor junior faculty members, and match mentors with summer undergraduate research fellows.
3. Ad hoc member of NIH study sections for National Institute of General Medical Sciences, NIH—I reviewed grant applications and participated in peer review. I have provided review for the Burroughs-Wellcome Foundation, and for ARC (Arthritis Research Campaign), United Kingdom.
4. Awards recognizing service and scholarly contributions—Arthritis Investigator Award from the Arthritis Foundation (1996), Gerlinger Research Foundation Award (1999), Foundation Scholars Research/Creativity Award (2006), the Dean’s Distinguished Faculty Award (2005-present), University Distinguished Professor (2011-present).

NSF BIOGRAPHICAL SKETCH

NAME: Lighty, JoAnn

ORCID: 0000-0002-1552-0098

POSITION TITLE & INSTITUTION: Dean, Boise State University

(a) PROFESSIONAL PREPARATION

INSTITUTION	LOCATION	MAJOR / AREA OF STUDY	DEGREE (if applicable)	YEAR YYYY
University of Utah	Salt Lake City, UT	Chemical Engineering	BS	1982
University of Utah	Salt Lake City, UT	Chemical Engineering	PHD	1988

(b) APPOINTMENTS

2017 - present Dean, Boise State University, Boise, ID

2017 - present Professor, Boise State University, Mechanical and Biomedical Engineering, Boise, ID

2017 - present Adjunct Professor, University of Utah, Chemical Engineering, Salt Lake City, UT

2013 - 2017 Division Director, National Science Foundation, ENG/CBET, Arlington, VA

2007 - 2013 Chair, University of Utah, Chemical Engineering, Salt Lake City, UT

2004 - 2007 Director (Founding), University of Utah, Institute for Combustion and Energy Systems, Salt Lake City, UT

1999 - 2017 Professor, University of Utah, Chemical Engineering, Salt Lake City, UT

1997 - 2004 Associate Dean for Academic Affairs, University of Utah, College of Engineering, Salt Lake City, UT

1995 - 1997 Associate Dean for Outreach, University of Utah, College of Engineering, Salt Lake City, UT

1994 - 1999 Associate Professor, University of Utah, Chemical Engineering, Salt Lake City, UT

1988 - 1994 Assistant Professor, University of Utah, Chemical Engineering, Salt Lake City, UT

(c) PRODUCTS

Products Most Closely Related to the Proposed Project

1. Lighty JS, Veranth JM, Sarofim AF. Combustion aerosols: factors governing their size and composition and implications to human health. J Air Waste Manag Assoc. 2000 Sep;50(9):1565-618; discussion 1619-22. PubMed PMID: 11055157.
2. Sahir A, Dansie J, Cadore A, Lighty J. A comparative process study of chemical-looping combustion (CLC) and chemical-looping with oxygen uncoupling (CLOU) for solid fuels. International Journal of Greenhouse Gas Control. 2014; 22:237-243. issn: 1750-5836
3. Sahir A, Cadore A, Dansie J, Tingey N, Lighty J. Process analysis of chemical looping with oxygen uncoupling (CLOU) and chemical looping combustion (CLC) for solid fuels. Proceedings of the 2nd International Conference on Chemical Looping. 2012.
4. Dansie J, Sahir A, Hamilton M, Lighty J. An investigation of steam production in chemical-looping combustion (CLC) and chemical-looping with oxygen uncoupling (CLOU) for solid fuels. Chemical Engineering Research and Design. 2015; 94:12-17. issn: 0263-8762
5. Hamilton M, Whitty K, Lighty J. Incorporating oxygen uncoupling kinetics into computational fluid

dynamic simulations of a chemical looping system. Energy Technology. 2016; 4(10):1237-1246. issn: 2194-4288

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

1. Ghiassi H, Lignell D, Lighty J. Soot oxidation by oh: theory development, model, and experimental validation. Energy & Fuels. 2016; 31(3):2236-2245. issn: 0887-0624
2. Lighty J, Cooper W, Hamilton B, Schottel B. NSF and innovations at the nexus of food, energy, and water systems. ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY. 2016; 251. issn: 0065-7727
3. Reinking Z, Shim H, Whitty K, Lighty J. Computational simulation of a 100 kW dual circulating fluidized bed reactor processing coal by chemical looping with oxygen uncoupling. International Journal of Greenhouse Gas Control. 2019; 90:102795. issn: 1750-5836
4. Reinking Z, Whitty K, Lighty J. A simulation-based parametric study of CLOU chemical looping reactor performance. Fuel Processing Technology. 2021 May 01; 215:106755. Available from: https://www.sciencedirect.com/science/article/pii/S0378382021000345 issn: 0378-3820
5. Sturrock A, Ghiassi S, Baker J, Lighty J, Paine R. Are Biofuels The Answer? A Preliminary Investigation Of Standard Diesel Versus Biodiesel Toxicity In Lung Cells. AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE. 2015; 191. issn: 1073-449X

(d) SYNERGISTIC ACTIVITIES

1. As Division Director at the NSF, I was one of the key architects in the formation of the convergent initiative Innovations at the Nexus of Food, Energy and Water Systems (INFEWS) involving nearly all the directorates, including ENG, CISE, SBE, GEO, MPS, and EHR. I was appointed as the NSF member for the OSTP, Task Force on the Nexus. In addition, to this and other initiatives, I was responsible for 16 programs and over $180M in funding.
2. My research in air quality and combustion has resulted in nearly $15M of funding; 17 Ph.D. and 11 M.S. students; and, 80+ peer-reviewed publications, 18 book chapters and document contributions (EPA SAB and NASEM reports), and over 180 research conference presentations and posters. I am a Fellow of the American Institute of Chemical engineers (AIChE), a Fellow of AAAS, and received the AIChE Environmental Division's Lawrence K. Cecil Award. I have been an active leader in AIChE and the Combustion Institute, both international forums for my work.
3. I have spent the majority of my career as an advocate for women in STEM. As Associate Dean for Academic Affairs at the Univ. of Utah, I was a key mentor for women in STEM and also served on the Presidential Committee for the Status of Women. In 2005, I was part of a collaborative ADVANCE grant that set up a network of women, Women in Engineering Leadership Network (WELI). Many of the initial women in this group, including myself, went on to academic leadership positions. I have received the Univ. of Utah's Linda Amos Award for Service to Women, SWE's Distinguished Engineering Educator Award, and the Utah Engineering Council Engineering Educator of the Year. Currently, I am a Board Member for the Girl Scouts of Silver Sage.

NSF BIOGRAPHICAL SKETCH

NAME: Browning, Jim

ORCID: 0000-0002-2768-1817

POSITION TITLE & INSTITUTION: Associate Professor, Boise State University

(a) PROFESSIONAL PREPARATION

INSTITUTION	LOCATION	MAJOR / AREA OF STUDY	DEGREE (if applicable)	YEAR YYYY
Missouri School of Science and Technology	Rolla, MO	Nuclear Engineering	BS	1983
Missouri School of Science and Technology	Rolla, Mo	Nuclear Engineering	MS	1985
University of Wisconsin Madison	Madison, WI	Nuclear Engineering and Engineering Physics	PhD	1988

(b) APPOINTMENTS

2006 - present Associate Professor, Boise State University, Electrical and Computer Engineering, Boise, ID

2001 - 2006 President, WatBro Consulting, Boise, ID

1999 - 2001 Director of Operations, PixTech, Inc, Boise, ID

1992 - 1999 Test manager, Program Manager, Micron Technology, Boise, ID

1988 - 1992 Research Scientist, Northeastern University, Boston, MA

(c) PRODUCTS

Products Most Closely Related to the Proposed Project

1. Oxford J, Cornell K, Romero J, Smith D, Yarnell T, Wood R, Jorcyk C, Lujan T, Albig A, Mitchell K, McDougal O, Fologea D, Estrada D, Tinker J, Nagarajan R, Warner D, Rohn T, Browning J, Beard R, Warner L, Morrison B, Fitzpatrick C, Uzer G, Bond L, Frahs S, Keller-Peck C, Pu X, Woodbury L, Turner M. Center of Biomedical Research Excellence in Matrix Biology: Building Research Infrastructure, Supporting Young Researchers, and Fostering Collaboration. International Journal of Molecular Sciences. 2020 March 20; 21(6):2141-. Available from: https://www.mdpi.com/1422-0067/21/6/2141 DOI: 10.3390/ijms21062141
2. Cornell Kenneth A, Benfield Kate, Berntsen Tiffany, Clingerman Jenna, Croteau Adam, Goering Spencer, Moyer Daniel, Provost Mariah, White Amanda, Plumlee Don, others. A Cold Atmospheric Pressure Plasma Discharge Device Exerts Antimicrobial Effects. International journal of latest trends in engineering & technology: IJLTET. 2020; 15(3):036.
3. Taff Jesse, Yates Mallory, Lee Carl, Shawver Sonya, Browning Jim, Plumlee Don. Fabrication of an Inductively Coupled Plasma Antenna in Low Temperature Co-Fired Ceramic. International Journal of Applied Ceramic Technology. 2013; 10(2):321--329.
4. Rowe Tyler, Pearlman Marcus, Browning Jim. Hysteresis in experimental I--V curves of electron hop funnels. Journal of Vacuum Science & Technology B, Nanotechnology and Microelectronics: Materials, Processing, Measurement, and Phenomena. 2013; 31(4):042204.

5. Shawver Sonya, Browning Jim. Modeling the characteristics of an inductively coupled plasma antenna for use in a micro-propulsion system. 2012 IEEE 55th International Midwest Symposium on Circuits and Systems (MWSCAS); 2012; c2012.

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

1. Browning Jim, Lee Carl, Plumlee Don, Shawver Sonya, Loo Sin Ming, Yates Mallory, McCrink Matt, Taff Jesse. A miniature inductively coupled plasma source for ion thrusters. IEEE Transactions on Plasma Science. 2011; 39(11):3187--3195.
2. Qin Shu, Chan Chung, Browning Jim, Meassick Steve. Charge transfer cross section of He+ in collisional helium plasma using the plasma immersion ion implantation technique. Journal of applied physics. 1993; 74(3):1548--1552.
3. Qin Shu, Chan Chung, McGruer Nicol E, Browning Jim, Warner Keith. The response of a microwave multipolar bucket plasma to a high voltage pulse. IEEE transactions on plasma science. 1991; 19(6):1272--1278.
4. Browning JJ, Hershkowitz N, Intrator T, Majeski R, Meassick S. Radio-frequency wave interchange stability experiments below the ion cyclotron frequency. Physics of Fluids B: Plasma Physics. 1989; 1(8):1692--1701.
5. Yasaka Y, Majeski R, Browning J, Hershkowitz N, Roberts D. ICRF heating with mode control provided by a rotating field antenna. Nuclear Fusion. 1988; 28(10):1765.

(d) SYNERGISTIC ACTIVITIES

1. Browning has collaborated with Co-PI, Ken Cornell, on the teaching and training of undergraduate and graduate students in a Vertically Integrated Projects course in Plasma Medicine and Agriculture that is transdisciplinary and introduces students to other disciplines and to research. Over 50 students from engineering, biology, biochemistry, and health sciences have participated over 5 years.

2. Browning has supported over 50 undergraduate research students over 15 years in his laboratory training them in the areas of plasma physics and vacuum electron devices. These students are trained in design, fabrication, and testing of deices and systems. Over 40% of the students have been underrepresented groups in engineering (women and Hispanic).

Appendix C

Current & Pending Support

Appendix C contains current and pending grant support for faculty on the FDIC project team in the following order.

- PI McDougal
- Co-PI Warner
- Co-PI Oxford
- Co-PI Lighty
- Co-PI Browning

CURRENT AND PENDING SUPPORT

Owen M. McDougal

Owen McDougal

ACTIVE

1R01H138992-01 (McDougal) NIH - University of Washington Using Fortilin Inhibitors to Halt Atherosclerosis The major goals of this project are to assess small molecule inhibitors for their inhibition of the protein fortilin.	7/1/2020 – 5/31/2021 FY 2020 $81,354	Person Months 1 mo. Summer

ACTIVE

ISDA SCBG (McDougal) Idaho State Department of Agriculture, US Department of Agriculture Award No: 2017 SCBGP-FB Fast, Accurate, and Economical Evaluation of Acrylamide Content in Fried Potato Products	08/01/2018 - 07/31/2021 $121,556	Person Months 1 mo. Summer

ACTIVE

BUILD Dairy (McDougal) BUILD Dairy Program Spectroscopic Investigation of Bioactive Protein Constituents in Whey	1/15/2021 – 8/15/2024 $137,400	Person Months N/A

ACTIVE

IGEM Commerce (McDougal) IGEM Commerce PEF Potato Processing Advantage	7/01/2021 – 6/30/2023 $291,770	Person Months 1 mo. Summer

PENDING

ISDA SCBG (McDougal) Idaho State Department of Agriculture, US Department of Agriculture Impact of Smoke on Potato Growth, Storage and Profitability	10/01/2021 – 9/30/2023 $151,416	Person Months 1 mo. Summer

PENDING

ISDA SCBG (McDougal) Idaho State Department of Agriculture, US Department of Agriculture Improving Grape Extraction with PEF to Make Wine Better	8/15/2021 – 8/15/2023 $164,783	Person Months 1 mo. Summer

NSF CURRENT AND PENDING SUPPORT

PI/co-PI/Senior Personnel: Warner, Lisa

PROJECT/PROPOSAL CURRENT SUPPORT

1. Project/Proposal Title: Using Fortilin Inhibitors to Halt Atherosclerosis

   Proposal/Award Number (if available):

   Source of Support: University of Washington/NIH

   Primary Place of Performance: Boise State University

   Project/Proposal Support Start Date (if available): 2020/03

   Project/Proposal Support End Date (if available): 2021/07

   Total Award Amount (including Indirect Costs): $81,354

   Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2020	1

2. Project/Proposal Title: Molecular Mechanisms of the Posttransciptional Regulator LARP6

   Proposal/Award Number (if available):

   Source of Support: Texas State University/National Institute of Health

   Primary Place of Performance: Boise State University

   Project/Proposal Support Start Date (if available): 2019/10

   Project/Proposal Support End Date (if available): 2022/08

   Total Award Amount (including Indirect Costs): $40,006

   Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2019	1

3. Project/Proposal Title: Mechanistic Investigation on Carrier Protein Recognition in Quorum Signal Synthases

   Proposal/Award Number (if available):

Source of Support: National Science Foundation

Primary Place of Performance: Boise State University

Project/Proposal Support Start Date (if available): 2019/08

Project/Proposal Support End Date (if available): 2022/07

Total Award Amount (including Indirect Costs): $466,859

Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2020	0.75
2021	0.75
2022	0.75

4. Project/Proposal Title: RII Track-4: Using in-cell NMR to follow 13C-fluxomics in Living Cells

Proposal/Award Number (if available):

Source of Support: National Science Foundation

Primary Place of Performance: Boise State University

Project/Proposal Support Start Date (if available): 2017/09

Project/Proposal Support End Date (if available): 2021/08

Total Award Amount (including Indirect Costs): $193,997

Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2017	3
2018	1
2019	3

PROJECT/PROPOSAL PENDING SUPPORT

1. Project/Proposal Title: Regulation of Collagen Type I Expression by Chaperone-Mediated mRNA Remodeling

Proposal/Award Number (if available):

Source of Support: National Institutes of Health/DHHS

Primary Place of Performance: Boise State University

Project/Proposal Support Start Date (if available): 2021/07

Project/Proposal Support End Date (if available): 2024/06

Total Award Amount (including Indirect Costs): $407,504

Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2021	1
2022	1
2023	1

NSF CURRENT AND PENDING SUPPORT

PI/co-PI/Senior Personnel: OXFORD, JULIA

NSF ID: 000432689@nsf.gov

PROJECT/PROPOSAL CURRENT SUPPORT

1. Project/Proposal Title: Idaho INBRE Program 4, BSU Block Grant

   Proposal/Award Number (if available): P20GM103408

   Source of Support: NIH (Federal Flow-Through University of Idaho)

   Primary Place of Performance: Boise State University

   Project/Proposal Support Start Date (if available): 2019/05

   Project/Proposal Support End Date (if available): 2024/04

   Total Award Amount (including Indirect Costs): $729,059

   Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2021	1
2022	1
2023	1
2024	1

2. Project/Proposal Title: Dynamically Controlled Plasma Scalpel for Wound Debridement

   Proposal/Award Number (if available): R15EB024930

   Source of Support: NIH

   Primary Place of Performance: Boise State University

   Project/Proposal Support Start Date (if available): 2018/09

   Project/Proposal Support End Date (if available): 2021/09

   Total Award Amount (including Indirect Costs): $362,242

   Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2021	0.01

3. Project/Proposal Title: Replicating Marrow Mechanics of Stem cells Ex vivo

   Proposal/Award Number (if available): 004886012687313

   Source of Support: NIH (Federal flow-through University of Pittsburgh)

   Primary Place of Performance: Boise State University

   Project/Proposal Support Start Date (if available): 2018/03

   Project/Proposal Support End Date (if available): 2021/02

   Total Award Amount (including Indirect Costs): $133,050

   Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2021	0.01

4. Project/Proposal Title: Gateway Scholarships for Biological Sciences

   Proposal/Award Number (if available): 1644233

   Source of Support: National Science Foundation

   Primary Place of Performance: Boise State University

   Project/Proposal Support Start Date (if available): 2017/02

   Project/Proposal Support End Date (if available): 2022/01

   Total Award Amount (including Indirect Costs): $1,000,000

   Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2021	0.25

5. Project/Proposal Title: Center of Biomedical Research Excellence in Matrix Biology Phase II

   Proposal/Award Number (if available): P20GM109095

   Source of Support: NIH

   Primary Place of Performance: Boise State University

Project/Proposal Support Start Date (if available): 2014/06

Project/Proposal Support End Date (if available): 2024/05

Total Award Amount (including Indirect Costs): $10,537,493

Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2021	4.5
2022	4.5
2023	4.5

PROJECT/PROPOSAL PENDING SUPPORT

1. Project/Proposal Title: Vision and Change in Undergraduate Biology Education (this proposal)

   Proposal/Award Number (if available):

   Source of Support: National Science Foundation

   Primary Place of Performance: Boise State University

   Project/Proposal Support Start Date (if available): 2022/01

   Project/Proposal Support End Date (if available): 2025/01

   Total Award Amount (including Indirect Costs): $571,293

   Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2022	1
2023	1
2024	1

2. Project/Proposal Title: Biomedical Research Facilities

   Proposal/Award Number (if available):

   Source of Support: NIH

   Primary Place of Performance: Boise State University

   Project/Proposal Support Start Date (if available): 2021/10

Project/Proposal Support End Date (if available): 2026/09

Total Award Amount (including Indirect Costs): $8,000,000

Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2022	0.01
2023	0.01
2024	0.01
2025	0.01
2026	0.01

NSF CURRENT AND PENDING SUPPORT

PI/co-PI/Senior Personnel: Lighty, JoAnn

PROJECT/PROPOSAL CURRENT SUPPORT

1. Project/Proposal Title: Idaho National Laboratory/ Boise State University Employee Education Program FY 2019

   Proposal/Award Number (if available):

   Source of Support: Idaho National Laboratory

   Primary Place of Performance: Boise State University

   Project/Proposal Support Start Date (if available): 2018/10

   Project/Proposal Support End Date (if available): 2023/09

   Total Award Amount (including Indirect Costs): $88,550

   Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2021	0.1
2022	0.1
2023	0.1

2. Project/Proposal Title: Development of Enabling Technologies for Chemical Looping Combustion & Chemical Looping with Oxygen Uncoupling

   Proposal/Award Number (if available):

   Source of Support: University of Utah/US Department of Energy

   Primary Place of Performance: Boise State University, Boise ID

   Project/Proposal Support Start Date (if available): 2017/09

   Project/Proposal Support End Date (if available): 2022/12

   Total Award Amount (including Indirect Costs): $50,116

   Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed

Year	Person-months per year committed
2017	0.5
2018	0.5
2019	0.5
2020	0.5
2021	0.1

3. Project/Proposal Title: Boise State Univ.Nuclear Science and Engineering Fellows and Scholars

   Proposal/Award Number (if available):

   Source of Support: US Department of Energy

   Primary Place of Performance: Boise State University, Boise ID

   Project/Proposal Support Start Date (if available): 2009/07

   Project/Proposal Support End Date (if available): 2022/06

   Total Award Amount (including Indirect Costs): $601,152

   Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2017	0.01
2018	0.01
2019	0.01
2020	0.01

PROJECT/PROPOSAL PENDING SUPPORT

1. Project/Proposal Title: Boise State Univ Nuclear Science and Engineering Fellows and Scholars

   Proposal/Award Number (if available):

   Source of Support: US Department of Energy

   Primary Place of Performance: Boise State University

   Project/Proposal Support Start Date (if available): 2022/06

Project/Proposal Support End Date (if available):

Total Award Amount (including Indirect Costs): $0

Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2022	0.01

2. Project/Proposal Title: AccelNet: N2S2 Network of Networks for a System of Systems for Enhanced Resilience in Food Supply Chains (subcontract)

   Proposal/Award Number (if available):

   Source of Support: National Science Foundation

   Primary Place of Performance: Boise State University

   Project/Proposal Support Start Date (if available): 2021/08

   Project/Proposal Support End Date (if available): 2026/07

   Total Award Amount (including Indirect Costs): $330,000

   Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2021	0.4
2022	0.4
2023	0.4
2024	0.4
2025	0.4

3. Project/Proposal Title: NSF INCLUDES Alliance: Engineering and Computer Science Idaho (ECSI) Alliance (THIS PROPOSAL)

   Proposal/Award Number (if available):

   Source of Support: National Science Foundation

   Primary Place of Performance: Boise State University

   Project/Proposal Support Start Date (if available): 2021/07

   Project/Proposal Support End Date (if available): 2026/06

Total Award Amount (including Indirect Costs): $8,769,581

Person-Month(s) (or Partial Person-Months) Per Year Committed to the Project:

Year	Person-months per year committed
2021	0.8
2022	0.8
2023	0.8
2024	0.8
2025	0.8

For New and Renewal Applications – DO NOT SUBMIT UNLESS REQUESTED

PHS 398 OTHER SUPPORT

Provide active and pending support for all senior/key personnel. **Other Support includes all financial resources, whether federal, non-federal, commercial or institutional, available in direct support of an individual's research endeavors, including but not limited to research grants, cooperative agreements, contracts, and/or institutional awards.** Training awards, prizes, or gifts do not need to be included.

There is no "form page" for reporting Other Support. Information on Other Support should be provided in the *format* shown below.

For information pertaining to the use of and policy for other support, see NIH Grants Policy Statement, Section 2.5.1: Just-in-Time Procedures. Neither the application under consideration nor the current PHS award for this project should be listed as Other Support.

Effort devoted to projects must be measured using "person months." NIH and other PHS agencies use the concept of "person months" as a metric for determining percent of effort. For more information about calculating person months, see NIH's Frequently Asked Questions on Person Months.

Format

Jim Browning

ACTIVE

1R15EB024930-01A1 (Browning) National Institutes of Health/DHHS Dynamically Controlled Plasma Scalpel for Wound Debridement The major goals of this project are to use a narrow plasma scalpel to selectively remove biofilms from chronic wounds	09/19/2018 – 09/20/2021 FY 2020 $94,858	Person Months 0.50 Summer
OVERLAP *(summarized for each individual): No overlap. This project uses plasma to remove biofilm using a small plasma device but it is specifically for wounds over a small area and does not include viruses.*		

ACTIVE

S4645/ PO # 203761 (Browning) Massachusetts Institute of Technology/US Department of Defense Empty State Electronics The major goals of this project are to understand the reliability and degradation of vacuum transistors	08/01/2018 - 07/31/2021 FY 2020 $111,065	Person Months 0.5 Summer
OVERLAP *(summarized for each individual) There is no overlap*		

ACTIVE

ES3987-SB-783720 (Subbaraman) University of Idaho/National Aeronautics & Space Administration Plasma-Jet Printing Technology for In-Space Manufacturing (ISM) and In-Situ Resource Utilization (ISRU) The major goals of this project are utilize plasma in space including printing and sterilization	08/01/2019 – 07/31/2022 FY 2020 $88,904	Person Months 0.50 Academic 0.25 Summer
OVERLAP *(summarized for each individual) This project uses plasma discharge for printing and sterilization but only for line discharges not arrays and only on stainless steel and glass.*		

ACTIVE		
FA9550-19-1-0101 (Browning) Air Force Office of Scientific Research/AIR FORCE/DOD Crossed-Field Device Physics in Perturbed Systems The major goals of this project are to study the device physics in crossed-field structures including magnetrons.	04/15/2019 – 04/14/2022 FY 2020 $310,732	Person Months 0.25 Summer
OVERLAP *(summarized for each individual) There is no overlap/*		
ACTIVE		
2020-67018-30789 (Browning) US Department of Agriculture Engineering Plasma Arrays to Remove Biofilms from Food Processing Surfaces The major goals of this project are to develop planar and radial plasma arrays to inactivate bacterial biofilms on steel surface s	06/01/2020 – 05/31/2023 FY 2020 $115,407	Person Months 0.30 Summer
OVERLAP *(summarized for each individual): No overlap. This project looks only at biofilms in food processing.*		
9147 (Browning) Purdue University/US Department of Defense Improving Performance of Crossed-Field Amplifiers Through Modulation Injection The major goals of this project are to improve understanding of Crossed-Field Amplifiers for high power applications	10/01/2020 – 09/30/2023 $224,448	Person Months 0.25 Summer
OVERLAP *(summarized for each individual) There is no overlap.*		
PENDING		
9494 (Browning) National Institutes of Health/DHHS An Engineered Robotic Plasma Array for Large Area Surface Decontamination The major goals of this project are to remove bacterial biofilms but particularly viruses from a variety of surfaces	04/01/2021 – 03/31/2024 $400,000	Person Months 0.25 Summer
OVERLAP *(summarized for each individual) This grant*		

Instructions for Selected Items

Project Number: If applicable, include a code or identifier for the project.

Source: Identify the agency, institute, foundation, or other organization that is providing the support. Include institutional, federal, public, and private sources of support.

Major Goals: Provide a brief statement of the overall objectives of the project, subproject, or consortium/contractual arrangement.

Dates of Approved/Proposed Project: Indicate the inclusive dates of the project as approved/proposed. For example, in the case of NIH support, provide the dates of the approved/proposed competitive segment.

Annual Direct Costs: In the case of an active project, provide the current year's direct cost budget. For a pending project, provide the proposed direct cost budget for the initial budget period.

Percent Effort/Person Months: Indicate calendar, academic, and/or summer months associated with each project. For an active project, provide the level of actual effort in person months (even if unsalaried) for the current budget period. Person months should be classified as academic, calendar, and/or summer. For a pending project, indicate the level of effort in person months as proposed for the initial budget period. Use either calendar months OR a combination of academic and summer months. If effort does not change throughout the year, it is OK to use only calendar months. However, you may use both academic and summer months if your institutional business process requires noting each separately even if effort remains constant. If effort varies between academic and summer months, use only academic and summer months, and do not use calendar months. In cases where an individual's appointment is divided into academic and summer segments, indicate the proportion of each devoted to the project.

Overlap: After listing all support, summarize for each individual any potential overlap with the active or pending projects and this application in terms of the science, budget, or an individual's committed effort.

Note for Other Support provided under a consortium/contractual arrangement or that is part of a multi-project award: *Indicate the project number, PD/PI, and source for the overall project, and provide all other information for the subproject only.*

Special Instructions for Joint University and Department of Veterans Affairs (VA) Appointments

Individuals with joint university and VA appointments may request the university's share of their salary in proportion to the effort devoted to the research project. The individual's salary with the university determines the base for computing that request. Signature by the Institutional Official on the application certifies that: (1) the individual is applying as part of a joint appointment specified by a formal Memorandum of Understanding between the university and the VA; and (2) there is no possibility of dual compensation for the same work, or of an actual or apparent conflict of interest regarding such work. Additional information may be requested by the awarding component(s).

Appendix D

Senior Personnel

Technician/Postdoc 1 – Primary oversight of Module I/II – Food chemistry/dairy science: The technician/postdoc will be required to have at least three years of relevant laboratory experience and be proficient in the operation, maintenance, repair, and training with scientific instrumentation (HPLC, GC, IR, UV-Vis, MS, CD, etc.), be versed in analyte extraction methodology from plant (potato, onion, sugar beet, etc.), dairy (cheese, protein powder, yogurt, etc.), solution (milk, blood, blanch water, fryer oil, etc.) matrices, and have a working knowledge of bioactivity assessment protocols (cell culture, microbiology, confocal microscopy, etc.). This individual will facilitate student projects conducted in the lab, work with industry patrons, assist the PI with grant reports, prepare quarterly updates for the Advisory Board, draft publications, prepare students for conference presentations, and provide content for new grant proposals. This individual will work with the PI and other team members to advance research initiatives and training programs, represent the center at scientific conferences, and serve as a point of contact for external customers to perform experiments.

Technician/Postdoc 2 – Primary oversight of Module III – Food process/food safety/engineering mockup site: The technician/postdoc will be required to have at least three years of experience as a process, factory, or laboratory technician in the food processing industry. This individual will be responsible for development of pilot food processing equipment and related experimental equipment, maintenance of the equipment, training of students and other researchers on the operation of the equipment and the relevant processes. This person will also participate with the research groups, workforce development programs, and the VIP courses. This person will split their time across several research groups.

Appendix E

Letters of Support & Instrument Quotes

Letters of support have been included in the following order.

- Advisory Board Members
    - Terry Gilton (Science & Technology)
    - Eric Bastian (Dairy Science)
    - Jim Gratzek (Food Processing)
- BSU Institutional Commitment – Research Lab Space to Construct the FDIC
    - Deans Durham (College of Arts and Sciences) & Lighty (College of Engineering)
- State of Idaho and National Impact of Food and Dairy Innovation Center at BSU
    - Celia Gould (Director, Idaho State Department of Agriculture)
    - Carolyn Bohach (PI and Director, Idaho INBRE Network – UI & ISU)
    - Frank Muir (President and CEO, Idaho Potato Commission)
    - Moya Dolsby (Executive Director, Idaho Wine Commission)
    - Emil Nashed (Executive Vice President – Dairy Product Science, National Dairy Council / Dairy Management Inc.)
    - Anand Rao (VP of Ingredients Innovation, Agropur USA, Bartlett, IL)
    - Lenny Bass (Campus & Academic Manager, Lactalis America Gp., Stitzer, WI)
    - Spencer Karabelas-Pittman (North American Agricultural Sustainability Lead, McCain Foods Ltd., Toronto, ON, Canada)
- Food Chemistry / Food Processing
    - J. Brian Scott (Sales & Marketing Manager, REYCO Systems, Inc., Caldwell, ID)
    - Jon Christensen (Dir. of Sales & Marketing, Id. Steel Products, Idaho Falls, ID)
    - Kyle Nehring (Owner, Teton Valley Brands, Meridian, ID)
    - Melanie Krause (Owner & Winemaker, Cinder Wines, Caldwell, ID)

    - Earl Sullivan (Owner & Winemaker, Telaya Wine Company, Caldwell, ID)
    - Jed Glavin (Owner & Winemaker, Split Rail Winery, Caldwell, ID)
    - Jay Hawkins (Owner, Lanae Ridge Vineyard, Boise, ID)
    - Dale Jeffers (Manager, Sawtooth and Skyline Vineyards, Caldwell, ID)
- Dairy Science
    - Brandon Carter (VP R&D, High Desert Milk, Burley, ID)
    - Loren Ward (Chief R&D Officer, Glanbia Nutritionals, Twin Falls, ID)
    - Varun Khanna (Director, R&D Innovation, Chobani, Twin Falls, ID) (*pending*)
- Science and Technology
    - Chris Hlubb (Founder & CEO, Hyacinth Proteins, Ellicott City, MD)
    - Jon Snedeker (Research Director, Lactea Therapeutics, Frederick, MD)
    - Steve Hues (Senior Member Technical Staff, Organic and AMC Lab Manager, Micron Corporate Laboratories, Micron Technology, Inc.) (*pending*)

Instrument quotes have been included for the Agilent GC-MS, Agilent LC-DAD-RI-MS and a Buchi Mini Spray Dryer B-290 demo unit for dairy protein spray-dry studies.

March 31, 2021

Re: Boise State University Food and Dairy Innovation Center

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to support your proposal to create a Food and Dairy Innovation Center (FDIC) at Boise State University. My chemical physics training, and research and development experience throughout my professional career at Micron and Apple in the materials, memory and processing devices, sensors and algorithms have provided me a solid foundation for my current work with WRVI Capital to identify emerging technologies and innovative business proposals designed for success now and in the future. As a long-term resident of Idaho and supporter of the local startup community, I am deeply committed to supporting the Idaho economy. I serve as an advisor to several emerging local companies, and find that your proposed FDIC aligns well with my interests to help Idaho companies remain competitive in their respective market spaces, while navigating the Digital Transformation we see happening globally.

I am willing to serve on the Advisory Board for the FDIC, and work with other members of the board to influence the successful transition of companies into the digital future by development of a skilled workforce to implement necessary modernization. I have enjoyed working with students at Boise State University over the decades, and my experience in science, technology, and business guarantees that my insights will be of value to your business partners and student development training programs.

I look forward to working with you to create this new center and know that your vision for the center will benefit students, private businesses, and the economy of Idaho while preserving the identify of our beloved state.

Sincerely,

Terry Gilton, Ph.D.
Partner
WRVI Capital

WESTERN DAIRY CENTER

750 North 1200 East
Logan, UT 84322-8700

March 29, 2021

Re: Boise State University Food and Dairy Innovation Center

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to support your proposal to create a Food and Dairy Innovation Center (FDIC) at Boise State University. As the Vice President, Innovation Partnerships at Dairy West, and Director of the Western Dairy Center at Utah State University, I work at the forefront of dairy industry needs and student training to meet the demand for skilled employees. I have worked with you for the past five years, beginning with our first Dairy Days event on the campus of Boise State University in 2017. Since that time four of your students have been funded by the BUILD Dairy program and had the opportunity to work within dairy industry internship programs. I was one of the founders of the BUILD program, which stands for Building University and Industry Linkages through Learning and Discovery. Over my 18-year career as the Vice President for Research and Development at Glanbia Nutritionals in Twin Falls, I became acutely aware of the decline in dairy scientists and the rising need in the state of Idaho for trained employees to enter an ever-more high tech workplace in dairy processing.

In our conversation, I identified that a dairy protein powder pilot laboratory was the highest priority deficiency to be addressed for dairy research within the region. To enhance the industry's position, I recommend filtration equipment coupled with spray-drying and agglomeration equipment to be able to produce dairy protein powders. Additionally, I recommend powder characterization instrumentation such as a particle size and zeta potential analyzer. Additionally, the ability to measure dispersibility, hydration and solubility properties will be needed.

I welcome the opportunity to work with you to establish a pilot facility at Boise State University, within the FDIC, where students can gain hands on training to experiment on next generation solutions of significant impact to the dairy industry. I have recognized the potential for Boise State University to be a partner to the dairy industry for many years, and am excited to serve as an Advisory Board member to the FDIC. Simply put, Idaho natives like to stay in Idaho and the dairy industry seeks to hire local. Hiring Idaho students is good for business and good for Idaho.

I believe the vision you articulated for the FDIC will serve our mutual interests well. I look forward to working with you to create this new center and know that our partnership will be good for Boise State University, the dairy industry, and the state of Idaho.

Sincerely,

Eric Bastian
Vice President, Innovation Partnerships at Dairy West
Director of the Western Dairy Center

FOOD PHYSICS™

March 31, 2021

Re: Boise State University Food and Dairy Innovation Center

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to support your proposal to create a Food and Dairy Innovation Center (FDIC) at Boise State University. As a mechanical engineer with a doctorate in Food Science & Technology and a senior executive with a 28-year career in the food industry, I have developed a broad working knowledge of sanitation, food regulations, food safety, food security, food process, pilot plant creation, emerging technology in food processing, techno-economic metrics, quality control and quality assurance, and design of innovate equipment to improve food processing efficiency, reduce energy requirements, minimize water usage, and reduce food waste.

Food Physics Group is the sole distributor of the world's leading pulsed electric field (PEF) system and a full-service provider of PEF for the food process industry in North America. We are in Boise because of its ideal location for doing business in the potato processing industry, Idaho's strong business climate and access to its skilled workforce. Our high technology solution is now current best practice in the French fry industry and has the potential to be incorporated very broadly in the food and dairy market. As PEF changes the processing characteristics of the ubiquitous cell membrane, it can be applied to a growing number of food and ingredient processing applications including potatoes, onions, sugar beets, hops, wine, dairy, meat, among others. Our work with Boise State to create the 'world's greatest potato chip' and to improve the quality of wine produced from Idaho grown grapes, are indications of ways we can partner to the benefit of the Idaho economy. I am willing to serve on the Advisory Board for the FDIC, and work with other members of the board to advise development and implementation of economically enabling solutions.

Food Physics has a vested interest in the training of a skilled workforce in Idaho. Training of innovative scientists, engineers and business leaders requires state of the art facilities, equipment, access to relevant and challenging projects and most importantly mentorship. We are supportive of your students and staff conducting experiments in our applications lab, and we look forward to working with you to gain insights into how we can bring value to Idaho's food processing industry through access to the FDIC. I and my staff has enjoyed working with students at Boise State University, and our leading position with a game-changing technology in food processing will create exciting opportunities for student to think in new ways and create the tools of the future.

I look forward to working with you to create this new center and know that your vision for the center will benefit students, private businesses, and the economy of Idaho.

Sincerely,

James Gratzek, PhD
Principal and Technical Director, Food Physics Group

BOISE STATE UNIVERSITY
COLLEGE OF ARTS AND SCIENCES

March 28, 2021

Re: Boise State University Food and Dairy Innovation Center

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

We are writing to support your proposal to create a Food and Dairy Innovation Center (FDIC) at Boise State University on the third floor of the Micron Center for Materials Research (MCMR). The third floor of the MCMR was designed as a transdisciplinary research environment where science and engineering faculty, staff and students, could gather their teams to conduct nationally recognized investigations at the forefront of STEM disciplines. This space is intended to serve as an incubator to benefit the Idaho economy through innovation, student training, creation of intellectual property, and serve as a site for industry collaboration. The FDIC aligns well with the spirit of the space in a way that inspires us to allocate up to four modular labs of 650 sq. ft. each. The cost to build-out each site is estimated to be $650,000. Provided IGEM HERC funds initiate the construction of the first of the laboratories for the FDIC, we will work with you and your team to secure the funds to complete the center construction through private donations, industry contributions, externally funded grants, and potentially even institutional investment.

It has been an exciting time to see the work done in chemistry to partner with the food and dairy industry, and the joining of transdisciplinary talents with engineering where cutting edge food safety engineering innovation is occurring. We look forward to working with you to create this new center and know that your vision for the center will benefit students, the food and dairy industry in Idaho, and Boise State University.

Sincerely,

Leslie Durham
Interim Dean
College of Arts and Sciences

JoAnn Lighty
Dean
College of Engineering

STATE OF IDAHO

DEPARTMENT OF AGRICULTURE

BRAD LITTLE
Governor
CELIA R. GOULD
Director

March 31, 2021

Dr. Owen McDougal
Department of Chemistry
College of Arts and Sciences
Boise State University

Dear Dr. McDougal,

The Idaho State Department of Agriculture (ISDA) has an important place in one of the state's largest industry sectors. We recognize Idaho's economic well-being is forever tied to the health of its farming and ranching. We also recognize new opportunities exist that will redefine the future of agriculture in Idaho. As agriculture changes, ensuring efficient and superior service delivery will be the department's foremost priority.

An important part of the ISDA is our various laboratories that include:

- Idaho Food Quality Assurance Lab
- Animal Health Lab
- Dairy Lab
- Seed Lab

ISDA laboratories are a multi-faceted network with the main emphasis of conducting regulatory and certification testing as well as the diagnosis and control of disease and pests. The laboratories provide support services and training in a variety of testing techniques and procedures. Individual laboratories oversee a number of state and federal programs and the laboratories provide support and consultation services to a variety of other public and private agencies.

The IGEM HERC proposal to create a Food and Dairy Innovation Center (FDIC) at Boise State University could benefit us in a number of ways, including: performing synergistic GC-MS and LC-MS analyses for external auditing purposes, and developing new methods for which the ISDA lab does not have the current resources to conduct. Methods development also may serve well for BSU student projects potentially leading to publication, in line with the university's academic mission.

FDIC could also provide student training and partner with ISDA for student internship opportunities at either venue or a combination of the two sites. This collaboration could create an employment pipeline to our agency in food science and food inspection industries. These two fields are currently in high demand throughout Idaho.

We look forward to working with the FDIC in the future to secure a synergistic and mutually beneficial relationship for the ISDA laboratory network and BSU. ISDA also intends to designate a high-level employee from ISDA labs to serve as a resource for the FDIC advisory board. Thank you for this opportunity to provide positive input of the important work and opportunities of the FDIC. Please feel free to contact us if you need additional information.

Sincerely,

Celia R. Gould

Celia Gould, Director

IDAHO INBRE
IDeA Network of Biomedical Research Excellence

Idaho INBRE Program
University of Idaho
875 Perimeter Dr MS 3025
Moscow, ID 83844-3025

Ph: 208.885.5373
Fx: 208.885.6904
inbre@uidaho.edu
inbre.uidaho.edu

March 31, 2021

Re: Boise State University Food and Dairy Innovation Center (FDIC)

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal:

I am writing to enthusiastically support your proposal to create a **Food and Dairy Innovation Center (FDIC)** at Boise State University (BSU). As Principle Investigator and Director of the Idaho INBRE Program, I am committed to bringing research excellence and rigor to institutions across Idaho. In the 20-years I have championed this effort, I have worked with exceptionally motivated, passionate, and effective Idaho leaders, including the INBRE Program Coordinator/Associate Director at the University of Idaho, Dr. Scott A. Minnich, BSU INBRE Program Leader, Dr. Julie Oxford, and Idaho State University INBRE Program Leader, Dr. Jim Groome. Also, I have been delighted to work with you and Dr. Lisa Warner in your roles as INBRE student mentors and biomedical research investigators.

Both INBRE and COBRE support created the Biomolecular Research Center at BSU that provides necessary instrumentation and technical skill to the growing research community. The proposed FDIC complements this research core facility and will provide a site for University of Idaho faculty, such as Dr. Gulhan Unlu and Dr. Brenda Murdoch, to partner their dairy and food science research with your infrastructure, transdisciplinary expertise, and student training center. Most exciting to me is the opportunity for students to develop skills in a state-of-the-art research/learning environment that is coupled with deriving pharmaceuticals and therapeutics from Idaho agricultural products. For example, the FDIC will provide the capabilities to convert plant or milk to high purity product that can then be assessed for bioactivity and therapeutic efficacy in the Biomolecular Research Center. Also, such projects will likely draw researchers and students from other Idaho institutions to do experiments in the FDIC.

The FDIC, detailed in your IGEM HERC application, is the kind of research-building that the Idaho INBRE Program strives for across the state. Together, the Idaho institutions of higher education are stronger than any one institution is alone; your plan builds this network. The FDIC will be a partnership that will benefit students, researchers, and most importantly, **the Idaho economy**. I wish you luck on getting funding.

Sincerely,

Carolyn H. Bohach

Carolyn Bohach, Distinguished Professor
Principle Investigator and Director
Idaho Idea Network for Biomedical Research Excellence

Supported by an Institutional Development Award (IDeA) from the National Institute of General Medical Sciences
of the National Institutes of Health under Grant #P20GM103408.

IDAHO POTATO COMMISSION

Impact of smoke on potato growth, storage, and profitability

Owen M. McDougal, Ph.D.
Professor and Chair
Department of Chemistry and Biochemistry
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

Idaho potatoes represent the only world-wide known potato brand. This year, Idaho potato growers will harvest around 300,000 acres of it' s Famous Potatoes, representing over one-third of all US potatoes. Every year, it is critical that the Idaho Potato Industry identifies ways to increase quality as it also increases demand. It's estimated that the Idaho Potato Industry, between the processors, growers, fresh pack shippers and support industry brings about $5 billion dollars per year into our state for revenues. It is an integral part of Idaho's economy

I am writing in support of the study your team proposes to conduct to assess the impact of smoke on potato growth, storage, and profitability. Unfortunately, smoke from wildfires appears to becoming a more common issue in Idaho. Gowers and processors have both noted negative impacts of smoke on potato yield, quality, and processability. While these observations have provided some insights on the sensitivity of different varieties to smoke damage, it would help the Idaho potato industry to have actual data on how smoke impacts different potato varieties. The Idaho State Department of Agriculture Specialty Crop Block grant proposal you have described will provide us with the needed data to make decisions about which varieties offer the best opportunities to maintain productivity and profitability under smokey conditions. We look forward to sharing results of your study with the potato industry.

Sincerely,

Frank Muir
President/CEO
Idaho Potato Commission

IDAHO WINE
COMMISSION

March 15, 2021

Re: Improving Grape Extraction with PEF to Make Wine Better

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to support the study proposed by you and Dr. Jim Gratzek of Food Physics Group to explore the advantages associated with pulsed electric field technology aimed at improving the profitability of grapes grown in Idaho.

Review of the work conducted at the University of Zaragoza, Spain demonstrates the potential benefits of pulsed electric field application for wineries. Evaluation and approval of pulsed electric field technology by the International Organization of Vine and Wine provides confidence that a pilot study in Idaho may advantage Idaho processed grapes toward products that are recognized for quality both nationally and internationally.

Access to PEF systems, through the Food Physics Group Boise applications center, provides Idaho grape growers locally sourced expertise to efficiently implement the technology into their harvest process. Use of PEF technology throughout the French fry industry provides assurance that PEF treatment is safe, efficient and effective at providing advantages across food and beverage sectors of the agricultural economy of Idaho.

On behalf of the Idaho Wine Commission, I am supportive of the pilot study proposed in your Idaho State Department of Agriculture Specialty Crop Block Grant proposal.

Sincerely,

Moya Dolsby

Moya Dolsby
Executive Director
Idaho Wine Commission

DAIRY MANAGEMENT INC.™

AMERICAN DAIRY ASSOCIATION®
NATIONAL DAIRY COUNCIL®
U.S. DAIRY EXPORT COUNCIL®

March 29, 2021

Re: Boise State University Food and Dairy Innovation Center

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to support your proposal to create a Food and Dairy Innovation Center (FDIC) at Boise State University. As the Executive Vice President – Dairy Product Science at the Dairy Management Inc., I lead the team that manages the grant proposal program focused on the advancement of cheese and dairy product technology and chemistry. I am an avid supporter of the BUILD Dairy program in the Western Region of the United States and frequently attend the annual meetings to hear students present their dairy science studies. The students you mentor through the BUILD Dairy program utilize a variety of optical spectroscopy (mid- and near-infrared spectroscopy, and circular dichroism), complemented by traditional dairy analysis methods (Kjeldahl and Leco nitrogen analysis) to study whey proteins, protein powders, milk and cheese. Your successful 2020 National Dairy Council (managed by Dairy Management Inc.) grant is a great example of the value your research projects provide for student training that are impactful to the dairy industry.

I work closely with Dr. Eric Bastian through his position with Dairy West. His recommendation to incorporate a dairy protein powder pilot lab into the FDIC would provide research opportunities in new product development that align exceedingly well with product innovation, new technology development, and product research investigations that my program supports. Idaho has become a leader in dairy in the United States, and Boise State University is positioned well to benefit the dairy industry through dairy product research projects, student training, and technology creation.

I look forward to working with you to establish a dairy protein pilot facility at Boise State University, within the FDIC, where students can gain hands-on training to experiment on next generation solutions of significant impact to the dairy industry. I believe your vision to create the FDIC will lead to nationally recognized, and impactful science achievement for Boise State University and the state of Idaho. I support your creation of this new center and know that your work will benefit Boise State University, the dairy industry, and the state of Idaho.

Sincerely,

Emil Nashed

Emil Nashed
Executive Vice President – Dairy Product Science
Dairy Management Inc.

March 29, 2021

Re: Boise State University Food and Dairy Innovation Center

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to support your proposal to create a Food and Dairy Innovation Center (FDIC) at Boise State University. In my position as the Vice President of Ingredients and Innovation for US Operations at Agropur, I have become familiar with your work and that of your students through engagement with the BUILD Dairy program. Agropur is North America's largest manufacturer of whey protein and we produce more than one billion pounds of cheese each year. Significant to our market vitality is the Jerome, ID facility where two of your BUILD Dairy sponsored students, Tyson Hardy and Rose Saxton, have spent summer months in internship positions. Agropur is committed to engaging in workforce training and development of skilled workers through our internship opportunities. The recruitment of Idaho natives to work in our Idaho facility makes good business sense.

I have enjoyed our conversations on the topic of whey protein analysis by optical spectroscopy, and appreciated your recent invitation to attend Rose Saxton's MS thesis defense on this topic. Our conversations on the development of infrared spectroscopy quality assurance methodology for whey protein led to the project objectives of your successful National Dairy Council grant. You have carried this momentum in dairy research into the current proposal to establish the FDIC, and have included in your plans a dairy protein spray-dry pilot facility, where students can conduct research on new product development. It appears that Boise State University is looking to expand student training in dairy research and I look forward to being a partner on this path.

I believe your vision to build a dairy research facility within the FDIC serves our mutual interests well. I look forward to working with you to create this new center and know that our partnership will be good for Boise State University, Agropur, and the state of Idaho.

Sincerely,

Anand Rao, PhD
VP of Ingredients and Innovation

March 29, 2021

Re: Boise State University Food and Dairy Innovation Center

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to support your proposal to create a Food and Dairy Innovation Center (FDIC) at Boise State University. As we discussed, the FDIC would be set up to educate future employees in new product development, production and quality control equipment, and formulation of new products for pharmaceutical and nutrition markets that are of great value to us. Lactalis is a $20 billion French owned cheese making company with our largest United States facility, which employs nearly 750 people, in Nampa, ID.

I serve as the Campus and Dairy Academy Manager at Lactalis American Group, and in that role, I participate in the BUILD Dairy program run through the Western Dairy Center. I have come to know you and your students through annual BUILD Dairy meetings and monthly webinars. I have arranged student internship opportunities for Boise State Students to gain factory experience. I welcome the opportunity to work with you to establish a FDIC at Boise State University that will partner with us to meet our needs for well-educated and well-trained future employees. Specific training aspects that would be of greatest value to our operations include the development of leadership skills, project management, engineering proficiency, and quality assurance knowledge.

I believe the vision you articulated for the FDIC will serve our mutual interests well. I look forward to working with you to create this new center and know that our partnership will be good for Boise State University, our business, and the state of Idaho.

Sincerely,

Lenny Bass
Campus and Dairy Academy Manager at Lactalis American Group
Belmont,Wisconsin, USA

Re: Assessing the impact of smoke on potato growth, metabolite profile, and product value

Owen M. McDougal, Ph.D.
Professor and Chair
Department of Chemistry and Biochemistry
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing in support of the study your team proposes to conduct to assess the impact of smoke on potato growth, storage, and profitability. The effects of climate change, seen through increased regional temperatures, increasingly dry conditions, and increasingly frequent and intense lightning storms, continue to cause perfect conditions for intense and widespread forest and rangeland fires across the western United States.

The direct impact of fires on land and infrastructure alongside the secondary effects of smoke canopy and air particulate matter concentrations on crop development and human safety are having a negative impact on our grower and producer livelihoods. In the past, we have witnessed the early death or poor growth of our crop that was exacerbated by compromised storage tolerance and enhanced disease. The result of heavy smoke growing seasons differentially impacts potato varieties and finished product quality. We also anticipate that the safety and wellbeing of our employees may be negatively affected.

While we continue to witness the deleterious effects of fire smoke, understanding how smoke affects different potato varieties will help inform our crop and employee management decisions. The Idaho State Department of Agriculture Specialty Crop Block grant proposal you have described will provide us access to data that will improve the yield and quality of potatoes entering manufacturing facilities. We look forward to reviewing the results of your study.

Sincerely,

Spencer Karabelas-Pittman, M.Sc.
North American Agricultural Sustainability Lead
McCain Foods Limited
439 King St. W. | 3rd Floor | Toronto, ON | M5V 1K4 | Canada
m: +1 416-576-0348
e: spencer.karabelas-pittman@mccain.ca

REYCO SYSTEMS, INC.

January 22, 2021

J. Brian Scott
REYCO Systems, Inc.
1704 Industrial Way
Caldwell, ID 83605

Dear Members of the IGEM selection committee,

I am writing in support of the FY21 IGEM application submitted by Dr. Owen McDougal of Boise State University and Dr. James Gratzek of Food Physics of Boise.

REYCO is an Idaho based manufacturer of food processing equipment with particular focus on potato and vegetable processing. We understand the focus of the grant is to demonstrate benefits of pulsed electric field (PEF) technology applied to the production of potato and other vegetable chips. In the last few years, REYCO has witnessed first-hand the way PEF technology has transformed French fry processing lines. We believe Food Physics technology will succeed in changing potato chip lines as well. We understand Food Physics equipment transforms food material properties nearly instantly and with much lower energy use than more traditional methods. REYCO is now working with Food Physics on joint development projects in areas beyond French fries, and it is in our best interest to see them succeed.

As the goal of the work is to develop scientific data to make chip lines more profitable and their existing unit operations more efficient, we feel the information from this study will also benefit REYCO Systems equipment design. More efficient chip processing of Idaho potato varieties may also incent the development of potato chip processing in Idaho as well.

We look forward to seeing Boise State University build additional technique and talent that will benefit Idaho industry and agriculture. We are confident that the use of state funds to support this research will benefit all of the Idaho potato industry.

Sincerely,

J. Brian Scott

Sales & Marketing Manager
REYCO Systems, Inc.

IDAHOSTEEL
Food Processing Equipment

Jon Christensen
Idaho Steel Products
255 E. Anderson St.
Idaho Falls, ID 83401

Dear Members of the IGEM selection committee,

I am writing in support of the FY21 IGEM application submitted by Dr. Owen McDougal of Boise State University and Dr. James Gratzek of Food Physics of Boise.

Idaho Steel Products (ISP) is an Idaho based manufacturer of food processing equipment with particular focus on potato processing. We understand the focus of the grant is to demonstrate benefits of pulsed electric field (PEF) technology applied to the production of potato chips. In the last few years, ISP has observed the progression of PEF technology as it has changed French fried Potato processing lines. We feel that FP's technology may also succeed in changing potato chip lines as well. Food Physics equipment transforms food material properties nearly instantly and with much lower energy use than more traditional methods. FP has created a long-term position for itself as an Idaho based equipment supplier in potato processing; ISP is now working with Food Physics on joint development projects in areas beyond French fries, and it is in our best interest to see FPG succeed.

As the goal of the work is to develop scientific data to make chip lines more profitable and their existing unit operations more efficient, we feel the information from this study will also benefit ISP equipment design. More efficient chip processing of Idaho potato varieties may also incent the development of potato chip processing in Idaho as well.

We look forward to seeing Boise State University build additional technique and talent that will benefit Idaho industry and agriculture. We are confident that the state funds used to support this research will do just that!

Sincerely,

Jon Christensen

Director of Sales & Marketing

Idaho Steel Products

IDAHO STEEL 100 YEARS 1918-2018

Kyle Nehring, Owner

Teton Valley Brands

3310 Cherry Lane Suite 215

Meridian, ID 83642

Dear Members of the IGEM selection committee,

As the founder and owner of Teton Valley Brands, I find value in Food Physics Group and their efforts to understand Pulsed Electric Field treatment of potatoes to generate improvements to manufacturing cost, product quality and food safety. I can see how this research and the associated technology could be essential in our production processes in the future.

We hope that Food Physics achieves a partnership with Boise State University through securing an I.G.E.M. grant. I am particularly interested in the development of acrylamide reduction in chips. We look forward to learning more and being a part of addressing this important food-safety concern. We anticipate that this increased scientific knowledge, achieved with funds from this I.G.E.M. grant, will have a positive impact on our business operations and the Idaho Potato Industry as a whole.

Thank you for the opportunity to weigh-in on our position on this important activity for Food Physics Group, Boise State, Teton Valley Brands and the Idaho Potato Industry.

Respectfully,

Kyle Nehring, Owner

Teton Valley Brands

Kyle.n@tetonvalleybrands.com

CINDER

March 18, 2021

Re: Improving Grape Extraction with PEF to Make Wine Better

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

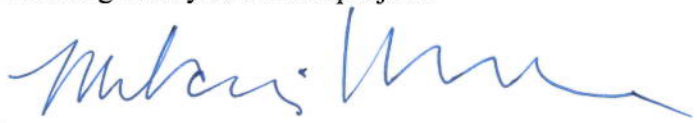
Dear Dr. McDougal,

I am writing to express my interest to participate in the study proposed by you and Dr. Jim Gratzek of Food Physics Group to use a pulsed electric field (PEF) flow cell to treat crushed grapes that I will turn into wine. During our conversation, we discussed focusing our study on Chardonnay and Cabernet Sauvignon grapes. The specific issue we run into with the processing of Chardonnay grapes is following fermentation, it is difficult to get the influence of the lees out of the wine. The integration of PEF treatment following fermentation may substitute a stirring step that we no longer use due to deleterious oxidative alteration of the wine, but a step that can amplify the quality of the resultant product. The use of PEF to achieve the benefits of stirring, but without the oxidation associated with the perturbation is a project in which we are interested to participate. With regard to Cabernet, the grapes mature in late fall, typically October, when morning temperatures are cool, in the 35-50°F range. Therefore, we need growers to harvest in the afternoon when the grapes are warmer. Cold grapes create problems in fermentation, requiring significant intervention to warm them during processing to get fermentation initiated effectively. The Cabernet grapes grown in Idaho often generate wine that is not as robust in color or tannins as those grown in Washington or California. PEF treatment could address both problems in a way that provides greater value for Idaho grown Cabernet grapes.

I am excited to partner with you and Dr. Gratzek to obtain Chardonnay grapes from Dale Jeffers of Sawtooth Vineyards, and Cabernet grapes from Jay Hawkins of Lanae Ridge Vineyard. We can process one ton of grapes through PEF trial and a second ton of grapes through a standard process to serve as a control trial. This project will be conducted for both Chardonnay and Cabernet grapes each season for two seasons.

Cinder Wines is excited to partner with you to conduct the proposed pilot study as described in your Idaho State Department of Agriculture Specialty Crop Block Grant proposal. I look forward to working with you on this project.

Sincerely,



Melanie Krause
Winemaker - Cinder Wines

Telaya
WINE CO.

March 17, 2021

Re: Improving Grape Extraction with PEF to Make Wine Better

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to express my interest to participate in the study proposed by you and Dr. Jim Gratzek of Food Physics Group to use a pulsed electric field (PEF) flow cell to treat crushed grapes that I will turn into wine. During our conversation, we discussed focusing our study on Tempranillo grapes grown at Lanae Ridge Vineyard by Jay and Shelly Hawkins in Caldwell, ID. These grapes are often challenging to extract pigment for color, even after traditional European winemaking methods that include soaking crushed grapes for ten days. I am excited to see if PEF treatment can improve extraction of pigment in less soaking time, leading to a better end product.

At Telaya Wine Co., I process 100 tons of grapes each season to produce 5,000 cases of wine. Each season presents challenges associated with grape growth conditions. To survey the seasonal variation of grapes, I look forward to working with you and Jim to process one ton of grapes each season for two seasons.

Telaya Wine Co. is excited to partner with you to conduct a pilot study as described in your Idaho State Department of Agriculture Specialty Crop Block Grant proposal. I look forward to working with you on this project.

Sincerely,

Earl Sullivan
Owner and Winemaker
Telaya Wine Company

SPLIT RAIL
WINERY

March 17, 2021

Re: Improving Grape Extraction with PEF to Make Wine Better

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to express my commitment to participate in the study proposed by you and Dr. Jim Gratzek of Food Physics Group to use a pulsed electric field (PEF) flow cell to treat crushed grapes that I will turn into wine. I have reviewed the PEF study conducted at the University of Zaragoza, Spain where improvements to wine quality were achieved. Split Rail Winery, where I am the winemaker, produces on the order of 5,000 – 6,000 cases of wine annually, and I embrace experimentation with new technology and fermentation practices, like the use of cement tanks. The grapes I use in my operation are a combination of Idaho-sourced fruit from Snake River Valley vineyards as well as vineyards in Columbia Valley and the Wahluke Slope in Washington.

You can count on Split Rail Winery to partner with you to conduct a pilot study as described in your Idaho State Department of Agriculture Specialty Crop Block Grant proposal. I look forward to working with you on this project.

Sincerely,

Jed Glavin
Winemaker
Split Rail Winery

March 18, 2021

Re: Improving Grape Extraction with PEF to Make Wine Better

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to express my interest to participate in the study proposed by you and Dr. Jim Gratzek of Food Physics Group to use a pulsed electric field (PEF) flow cell to treat crushed grapes that I grow for wineries in the region. My vineyard is 32 acres and I grow a variety of grapes on contract. Among my customers, I provide two acres of tempranillo grapes to Earl Sullivan at Telaya Wine Company. I have found the tempranillo plot to be the most problematic in the vineyard associated with the soil composition that was impacted by thirty years of nitrogen infusion due to the sheep paddock that was located in this region prior. The focus on PEF processing of tempranillo grapes could be a real benefit to improving the value of grapes grown in this portion of my vineyard. I welcome the opportunity to work with you and Dr. Gratzek, on this project in collaboration with Earl and his winery.

I am also excited to work with you by providing cabernet grapes through my contract with Melanie Krause of Cinder Wines. The late season harvest of cabernet grapes presents challenges to get the highest quality grapes off the vine and to the winery for processing at a temperature that is favorable for fermentation. The PEF treatment of these grapes could improve pigment and tannin extraction efficiency that would provide greater flexibility in my harvest times and improve the value of my grapes for sale to wineries. I am supportive of supplying grapes for this project.

Lanae Ridge Vineyard is excited to partner with you to conduct the proposed pilot study as described in your Idaho State Department of Agriculture Specialty Crop Block Grant proposal. I look forward to working with you on this project.

Sincerely,

Jay Hawkins
Owner
Lanae Ridge Vineyard

winemakers LLC | 1410 Lakeside Court, Suite #109, Yakima, WA 98902 • Tel 509-853-1000 • Fax 509-853-1005 • Web winemakersllc.com

March 18, 2021

Re: Improving Grape Extraction with PEF to Make Wine Better

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to express my interest to participate in the study proposed by you and Dr. Jim Gratzek of Food Physics Group to use a pulsed electric field (PEF) flow cell to treat crushed grapes that I grow for wineries in the region. I manage Sawtooth and Skyline vineyards, which are the largest vineyards in Idaho, with over 500 acres of grape vines. Melanie Krause, winemaker at Cinder Wines, is a customer for chardonnay grapes. I am willing to be a participant in the pilot project that you will be conducting with Melanie to compare PEF treated must to traditionally processed grapes. Under Melanie's chardonnay contract, I can provide one ton of grapes, each year for two years, required to conduct the study.

Sawtooth and Skyline Vineyards are excited to partner with you to conduct the proposed pilot study as described in your Idaho State Department of Agriculture Specialty Crop Block Grant proposal. I look forward to working with you on this project.

Sincerely,

Dale Jeffers
Manager
Sawtooth and Skyline Vineyards

HIGH DESERT MILK

March 30, 2021

Re: Boise State University Food and Dairy Innovation Center

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to support your proposal to create a Food and Dairy Innovation Center (FDIC) at Boise State University. In my role as the Director of Research and Development at High Desert Milk, I have become familiar with your work through the BUILD Dairy program and our mutual association with Dr. Eric Bastian. When my collaboration began with Maryland-based pharmaceutical and therapeutic drug development companies, Hyacinth Proteins and Lactea Therapeutics, I reached out to you for assistance with quantitative analysis of dairy proteins for purity assessment. The proximity of your lab to our Burley, ID based facility, and the analytical chemistry work you conduct with dairy products made our collaboration inevitable. As we have advanced very quickly down the path of seeking Food and Drug Administration regulatory compliance for the development of a dairy protein derived therapeutic from milk, I have expanded significantly the role of our collaboration.

At present, High Desert Milk is the sponsor of a BUILD Dairy proposal to fund the work of Joseph Collins, a second year PhD student in the Biomolecular Sciences Program at Boise State University, who works in your lab. We seek to hire your most recent graduate, Ms. Rose Saxton, whose thesis work on dairy proteins was sponsored by the BUILD Dairy program. We have expanded our work to include service sample mass spectrometry analysis conducted in the Biomolecular Research Center, and further have initiated cell culture and imaging work with Joseph, also conducted in the Biomolecular Research Center. Our project aligns well with the Idaho INBRE program and the Boise State University COBRE program in matrix biology. We are delighted to include Drs. Julie Oxford and Lisa Warner into our collaboration, and we are confident Boise State University will be a strong partner for our effort to generate value added therapeutics from agricultural raw materials, in our case milk.

The FDIC detailed in your IGEM HERC proposal is ideally suited to address the needs of our industry in a way that no other site in the state of Idaho does. I look forward to working with you to create this new center and know that our partnership will be good for Boise State University, our business, and the state of Idaho.

Sincerely,

Brandon Carter, PhD
Director of Research and Development, High Desert Milk

Research & Development
450 Falls Avenue, Suite 255
Twin Falls, Idaho 83301

208.735.4700
www.glanbianutritionals.com

glanbia nutritionals

March 31, 2021

Re: Boise State University Food and Dairy Innovation Center

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to support your proposal to create a Food and Dairy Innovation Center (FDIC) at Boise State University. I serve as the Chief R&D Officer at Glanbia Nutritionals, a company that is the largest processor of milk in Idaho, accounting for nearly one third of all milk processed in the State. We have invested $100's of millions of dollars in developing cheese and whey processing facilities in Idaho and have locations in Richfield, Twin Falls, Blackfoot and Gooding. Running an operation of the size and complexity of Glanbia Nutritionals requires access to skilled workers. I have worked with Dr. Eric Bastian from his time at Glanbia and more recently in his position at Dairy West, where he focuses his efforts on expanding the participation and impact of the BUILD Dairy program to provide dairy research opportunities for students and faculty at regional universities.

Glanbia Nutritionals sponsors student research projects through the BUILD Dairy program, but more importantly, we offer a multitude of internship opportunities to students. The interns that work with our scientists gain valuable hands-on, real-world exposure to the attributes of working in a modern dairy processing company. At Glanbia Nutritionals, it is advantageous for us to hire locally. Idaho students that seek employment in our Idaho facilities tend to stay with our company. The creation of the FDIC at Boise State University expands the capacity for us to partner with Boise State for the training of students in dairy science and engineering. I am supportive of this effort to establish the FDIC, and look forward to partnering with you to develop home-grown talent for careers in the Idaho dairy industry.

The FDIC at Boise State University will serve as a resource to the entire BUILD Dairy network and the regional dairy industry. I look forward to working with you to create this new center and know that our partnership will be good for Boise State, Glanbia Nutritionals, and the State of Idaho.

Sincerely,

Loren S. Ward, PhD
Chief R&D Officer
Glanbia Nutritionals, Twin Falls, ID

March 31, 2021

Re: Boise State University Food and Dairy Innovation Center

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to support your proposal to create a Food and Dairy Innovation Center (FDIC) at Boise State University. After nearly 25 years in a range of businesses from biomedical product development to the agricultural industries, I founded Hyacinth Proteins to isolate and purify naturally-derived compounds from dairy. My network connections drew my attention from my home operations in Maryland, to engage with the owners of High Desert Milk in Burley, ID. I found a receptive partner with Dr. Brandon Carter, the VP for R&D at High Desert Milk, to pursue the extraction of bioactive proteins from milk that I could use along with my regulatory expertise to elevate these ingredients to drug-grade standards in conjunction with the Food and Drug Administration.

The missing component in our first year was a local partner in research and development with the expertise to conduct qualitative and quantitative analysis of proteins from the dairy industry. Through the BUILD Dairy network and conversations with Dr. Eric Bastian of Dairy West, I quickly identified your work at Boise State University. Our collaboration and sponsorship of a BUILD Dairy proposal to fund a PhD student in your lab was complemented by the job offer we provided to a recent graduate from your lab as well. Recognizing the dairy research capabilities of your lab, and the Biomolecule Research Center core facility directed by Dr. Julie Oxford, we have gained critical access to experts that have been able to expedite and advance our purification efforts. We have further begun conversations to sponsor student work in the lab of Dr. Lisa Warner to explore protein structure-activity relationships.

I have worked with a lot of university and industry scientists in Maryland and around the world. The work that I have done with Boise State University has been integral to our current success and related to the immense technological resources you possess. I am excited to scale our operation in Idaho and will continue to be a partner and advocate for the work BSU has provided. I look forward to working with you to create this new center and know that your vision for the center will benefit students, private businesses like mine, and the economy of Idaho.

Sincerely,

Christopher Hlubb

Chris Hlubb
Founder and CEO
Hyacinth Proteins, LLC

March 31, 2021

Re: Boise State University Food and Dairy Innovation Center

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

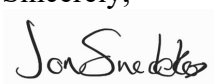
Dear Dr. McDougal,

I am writing to support your proposal to create a Food and Dairy Innovation Center (FDIC) at Boise State University. Our company, Lactea Therapeutics, is based in Frederick, MD, in proximity to the FDA, NIH, USAMRIID and numerous significant biotech and pharmaceutical companies. We recently entered into an agreement to work with Idaho-based agricultural producers to obtain important raw materials for advanced prophylactic and therapeutic research.

While we are close to many academic and federal resources, few have been able to provide the type of support we required to quickly develop, quantify and analyze the active pharmaceutical ingredients which have been produced for us by our partners in the region. Through our connection to Hyacinth Proteins, we were introduced to Dr. Eric Bastian of Dairy West. Through the BUILD Dairy network and our conversations, we were connected to your work at Boise State University. We have just proposed sponsorship of numerous BUILD Dairy proposals to fund graduate students in your lab and through the Biomolecular Research Center core facility directed by Dr. Julie Oxford. The past research performed by Dr. Oxford, and her colleague Dr. Lisa Warner are directly relevant to our future translational efforts and we believe that further coordination will allow us to expedite our drug development and has enhanced our confidence in the direction we are taking to isolate, identify and purify agricultural components from the dairy industry.

We look forward to continuing our work at BSU, which has recently resulted in advanced cell culture analysis of our proposed drug product in human cells which validated a major action of our pharmaceutical. The work that I have done with Boise State University has been integral to our current success and the pending release of our first drug product. I am excited to scale our operation in Idaho and will continue to be a partner and advocate for the work BSU has provided. I look forward to working with you to create this new center and know that your vision for the center will benefit students, private businesses like mine, and the economy of Idaho.

Sincerely,



Jon Snedeker
Research Director
Lactea Therapeutics, LLC

Agilent Technologies

Quotation

Mr. Owen McDougal
Boise State University
1910 University Dr
Boise ID 83725-0399

Quote No.	Create Date	Delivery Time	Page
3530232	03/29/2021	7 Weeks	1 of 6

Contact	Phone no.	Valid to
Craig Blackett	3852407056	06/27/2021

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Genomics	orders@agilent.com	512-321-3128
Pathology	customer.service@agilent.com	800-566-3256
Instruments	Lscainstrumentsales@agilent.com	302-633-8953

1-800-227-9770 Option 1

Item	Product/Description	Qty/Unit	Unit List Price	Discount Amount	Extended Net Price
1000	**G7077BA**	1.000 EA	**84,483.00 USD**	**20,698.35-**	**63,784.65**

5977B Inert Plus MSD Turbo EI Bundle with Extractor EI Source and Data System (Software, PC and Monitor), and additional G1710FA Data License.

With the following configuration:
Ship-to Country : USA
Add ChemStation DA w/ MassH Fam
GC/MSD InertPlus EI for 8890 GC
GCMSD Academic Option
Substitute IDP3 Oil Free Scroll Pump
Installation (44K)
Introduction
1 Year SW Update/Phone Assist (44W)

Special discount of 24.50 % is applied.

2000	**G3540A**	1.000 EA	**27,611.00 USD**	**6,764.70-**	**20,846.30**

Agilent 8890 GC System Custom

With the following configuration:
Ship-to Country : USA
Country of Origin : United States
8890 100psi Split/splitless Inlet Accy
MSD Interface
Factory plumbing For quick installation
Exhaust Deflector Assy
Installation (44K)
Introduction

Special discount of 24.50 % is applied.

3000	**G3397B**	1.000 EA	**2,665.00 USD**	**652.93-**	**2,012.07**

Agilent Technologies

Quotation

Quote No.	Create Date	Delivery Time	Page
3530232	03/29/2021	7 Weeks	2 of 6

Contact	Phone no.	Valid to
Craig Blackett	3852407056	06/27/2021

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Pathology	customer.service@agilent.com	800-566-3256
Instruments	Lscainstrumentsales@agilent.com	302-633-8953

1-800-227-9770 Option 1

Mr. Owen McDougal
Boise State University
1910 University Dr
Boise ID 83725-0399

Item	Product/Description	Qty/Unit	Unit List Price	Discount Amount	Extended Net Price
	Ion Gauge Kit for 5977 MSD. With the following configuration: Ship-to Country : USA Installation (44K)				
Special discount of 24.50 % is applied.					
4000	**G4513A**	1.000 EA	**9,047.00 USD**	**2,216.52-**	**6,830.48**
	7693A Autoinjector Includes transfer turret, 16-sample turret, mounting post, parking post for GC. 10ul syringe, and With the following configuration: Ship-to Country : USA Installation (44K) Introduction				
Special discount of 24.50 % is applied.					
5000	**G4514A**	1.000 EA	**10,642.00 USD**	**2,607.30-**	**8,034.70**
	7693 Tray, 150 vial includes three removable With the following configuration: Ship-to Country : USA Installation (44K) Introduction				
Special discount of 24.50 % is applied.					
6000	**G1033C**	1.000 EA	**6,285.00 USD**	**1,539.83-**	**4,745.17**

Agilent Technologies

Quotation

Quote No.	Create Date	Delivery Time	Page
3530232	03/29/2021	7 Weeks	3 of 6

Contact	Phone no.	Valid to
Craig Blackett	3852407056	06/27/2021

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Genomics	orders@agilent.com	512-321-3128
Pathology	customer.service@agilent.com	800-566-3256
Instruments	Lscainstrumentsales@agilent.com	302-633-8953

1-800-227-9770 Option 1

Mr. Owen McDougal
Boise State University
1910 University Dr
Boise ID 83725-0399

Item	Product/Description	Qty/Unit	Unit List Price	Discount Amount	Extended Net Price
	Latest NIST MS Library Bundle includes over 350K EI spectra for over 300K compounds (40K increase) and GC Methods/Retention indices library (nist_ri) with 139K compounds				
	Special discount of 24.50 % is applied.				
7000	**H2149A**	1.000 EA	**7,889.00 USD**	**1,932.81-**	**5,956.19**
	Method and Application Consulting On-site consulting for a maximum of 4 participants. Certificates and manuals not included.				
	With the following configuration: Ship-to Country : USA Two Day On-site (Includes Travel)				
	Special discount of 24.50 % is applied.				
8000	**SYS-GM-5977T**	1.000 EA	**12,383.00 USD**	**3,033.84-**	**9,349.16**
	GCMS 5977 Turbo System				
	Academic Extended Warranty - 3yrs total				
	Special discount of 24.50 % is applied.				

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Quotation

Quote No.	Create Date	Delivery Time	Page
3530232	03/29/2021	7 Weeks	4 of 6

Contact	Phone no.	Valid to
Craig Blackett	3852407056	06/27/2021

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Instruments	Lscainstrumentsales@agilent.com	302-633-8953

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Boise ID 83725-0399

Item	Product/Description	Qty/Unit	Unit List Price	Discount Amount	Extended Net Price

Gross Amount	: $	161,005.00
Total Discount	: $	39,446.28
Net Amount	: $	121,558.72
Total	**: $**	**121,558.72**

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Quotation

Quote No.	Create Date	Delivery Time	Page
3530232	03/29/2021	7 Weeks	5 of 6

Contact	Phone no.	Valid to
Craig Blackett	3852407056	06/27/2021

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- Shipping and Handling Charges: Orders with a value less than $4000 or those requiring special services such as overnight delivery may be subject to additional shipping & handling fees. Some of these charges may be avoided by ordering via the Web
- Payment Terms: Net 30 days from invoice date, subject to credit approval.

* Quotation Validity: This quotation is valid for 90 days unless otherwise indicated.
* Warranty period for instrumentation is 1 year. The Warranty period for columns and consumables is 90 days.

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Quotation

Quote No.	Create Date	Delivery Time	Page
3530232	03/29/2021	7 Weeks	6 of 6

Contact	Phone no.	Valid to
Craig Blackett	3852407056	06/27/2021

Mr. Owen McDougal
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Agilent Payment Method: ACH
Credit card accepted only at the time of order placement.
Agilent will charge 3% of the invoiced amount, when term invoices are paid with a credit card.

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Quotation

Mr. Owen McDougal
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Quote No.	Create Date	Delivery Time	Page
3530474	03/29/2021	3 Weeks	1 of 7

Contact	Phone no.	Valid to
Craig Blackett	3852407056	06/27/2021

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Genomics	orders@agilent.com	512-321-3128
Pathology	customer.service@agilent.com	800-566-3256
Instruments	Lscainstrumentsales@agilent.com	302-633-8953

1-800-227-9770 Option 1

Item	Product/Description	Qty/Unit	Unit List Price	Discount Amount	Extended Net Price
1000	**G6125CA**	1.000 EA	**136,143.00 USD**	**33,355.04-**	**102,787.96**

Agilent LC/MSD for OpenLAB CDS 2. Includes AP-ESI Ion Source, OpenLAB CDS 2 software, and MS Connection.

With the following configuration:
Ship-to Country : USA
MSD with OpenLab CDS Workstation SW
Installation (44K)
Introduction
1 Year SW Update/Phone Assist (44W)

Special discount of 24.50 % is applied.

2000	**G7111B**	1.000 EA	**28,458.11 USD**	**6,972.24-**	**21,485.87**

1260 Infinity II Quaternary Pump, maximum pressure 600bar. Includes quaternary pump with integrated 4-channel degassing unit, column, connecting capillaries, solvent cabinet, solvent bottles and CAN cable.

With the following configuration:
Manual DVD for 1220/1260/1290 : DVD included
Add Tool Kit (001) : Tool Kit included
Max uptime kit sel (007) : Max uptime kit selected
Active Inlet Valve (032) : active Inlet Valve selected
Select bundled column : Poroshell 120 EC-C18 4.6x100mm
Ship-to Country : USA
HPLC System Tool Kit 1260 Infinity II
Agilent Lab Advisor Advanced Software
Max Uptime Kit
Active Seal Wash
Active Inlet Valve (AIV)
Poroshell 120 EC-C18 4.6x100mm, 2.7µm
Installation (44K)
Introduction

Agilent Technologies

Quotation

Quote No.	Create Date	Delivery Time	Page
3530474	03/29/2021	3 Weeks	2 of 7

Contact	Phone no.	Valid to
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Consumables	cag_sales-NA@agilent.com	302-633-8901
Genomics	orders@agilent.com	512-321-3128
Pathology	customer.service@agilent.com	800-566-3256
Instruments	Lscainstrumentsales@agilent.com	302-633-8953

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Mr. Owen McDougal
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1910 University Dr
Boise ID 83725-0399

Item	Product/Description	Qty/Unit	Unit List Price	Discount Amount	Extended Net Price
Special discount of 24.50 % is applied.					
3000	**G7129A**	1.000 EA	**23,653.00 USD**	**5,795.00-**	**17,858.00**
	1260 Infinity II Vialsampler for use up to 600 bar. Includes 100 uL metering device and a 100 uL sample loop plus integrated needle flush port. With the following configuration: Drawer kit selection : Standard drawer (6x11 vials) Type of SW license : OpenLab CDS 2 System Driver Add thermostat (101) : InfLab sample thermostat incl. Ship-to Country : USA Standard drawer (6x11 vials) Agilent InfinityLab Sample Thermostat Installation (44K) Introduction				
Special discount of 24.50 % is applied.					
4000	**G7116A**	1.000 EA	**7,730.00 USD**	**1,893.86-**	**5,836.14**
	1260 Infinity II Multicolumn Thermostat MCT With the following configuration: Quick-Connect HE 3ul (062) : Quick-Connect HE 3 ul selected Manual DVD for 1220/1260/1290 : DVD included Ship-to Country : USA valve drive for 1260 Infinity II MCT Quick-Connect HE Large id Installation (44K) Introduction				
Special discount of 24.50 % is applied.					
5000	**G7115A**	1.000 EA	**22,673.00 USD**	**5,554.89-**	**17,118.11**

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3530474	03/29/2021	3 Weeks	3 of 7

Contact	Phone no.	Valid to
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Item	Product/Description	Qty/Unit	Unit List Price	Discount Amount	Extended Net Price
	1260 Infinity II Diode Array Detector WR. Provides 120Hz data acquisition rate RFID tags for flow cell and lamp. Includes long-life deuterium and tungsten lamp. Flow cell must be ordered as option. With the following configuration: Manual DVD for 1220/1260/1290 : DVD not included Ship-to Country : USA Standard flow cell 10mm, 13uL, 120bar Installation (44K) Introduction				
Special discount of 24.50 % is applied.					
6000	**G7162A**	1.000 EA	**12,866.00 USD**	**3,152.18-**	**9,713.82**
	1260 Infinity II Refractive Index detector. Up to 72Hz data rate, with integrated 8uL standard flow cell. With the following configuration: Ship-to Country : USA Installation (44K) Introduction				
Special discount of 24.50 % is applied.					
7000	**M8431AA**	1.000 EA	**1,061.00 USD**	**259.95-**	**801.05**
	OpenLab CDS Instrument Connection for 1 LC, GC, Analog/Digital Converter, 3D UV/DAD or MS detector. With the following configuration: Ship-to Country : USA 3D UV/DAD Connection				

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3530474	03/29/2021	3 Weeks	4 of 7

Contact	Phone no.	Valid to
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Boise State University
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Item	Product/Description	Qty/Unit	Unit List Price	Discount Amount	Extended Net Price
	Special discount of 24.50 % is applied.				
8000	**H2149A**	1.000 EA	**7,889.00 USD**	**1,932.81-**	**5,956.19**
	Method and Application Consulting On-site consulting for a maximum of 4 participants. Certificates and manuals not included. With the following configuration: Ship-to Country : USA Two Day On-site (Includes Travel)				
	Special discount of 24.50 % is applied.				
9000	**SYS-LM-QUAD-E**	1.000 EA	**31,104.00 USD**	**7,620.48-**	**23,483.52**
	LCMS Single Quad System Enh Features With the following configuration: Ship-to Country : USA Academic Extended Warranty - 3yrs total				
	Special discount of 24.50 % is applied.				

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Quote No.	Create Date	Delivery Time	Page
3530474	03/29/2021	3 Weeks	5 of 7

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Item	Product/Description	Qty/Unit	Unit List Price	Discount Amount	Extended Net Price

Gross Amount	: $	271,577.11
Total Discount	: $	66,536.45
Net Amount	: $	205,040.66
Total	**: $**	**205,040.66**

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Quotation

Quote No.	Create Date	Delivery Time	Page
3530474	03/29/2021	3 Weeks	6 of 7

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* Warranty period for instrumentation is 1 year. The Warranty period for columns and consumables is 90 days.

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ordermanagement@buchi.com
www.buchi.com

Customer Address

Boise State University
Chemistry and Biochemistry
1910 University Drive
Boise ID 83725-1520
UNITED STATES

Delivery Address

Boise State University - Chemistry and Biochemistry
1910 University Drive
Boise ID 83725-1520
UNITED STATES

Sales Quotation

QUO-138777-F5F6R0

Customer Number:	A288363	Date:	4/1/2021
Customer Contact:	McDougal, Owen	Your contact:	Leslie Ope
Customer Reference:		Phone:	415-715-4641
Valid until:	5/3/2021	E-mail:	Ope.L@buchi.com

We are pleased that you have chosen our products and services. We offer as follows.

Pos	Description	Qty	Unit	Price	Total USD
10	D-341000287852 044699 Mini Spray Dryer B-290 DEMO UNIT Advanced for organic and aqueous solutions. For small sample volumes up to 1000 ml/h. Including two glass cylinders, safety curtain, feed switch valve and two nozzle caps.	1.00	pcs	17,853.54	17,853.54
20	34004868 Shipping and Handling	1.00	pcs	2,250.00	2,250.00
			Net Amount	$	20,103.54
Total				**$**	**20,103.54**

The item quoted is a SOLD used B-290 Advanced Spray Dryer. Informational Purposes Only.
Terms of Delivery: Freight prepaid
Payment Terms: 30 days net

To view the terms and conditions of sale, visit http://www.buchi.com/us-en/service-support/terms-conditions.

Please note:
This Buchi quotation does not include any applicable tax.
Reference the quote number on any correspondence regarding this quotation, including when placing an order.

To place an order, please send your purchase order to ordermanagement@buchi.com or fax to 302-652-8777 for immediate processing.

To place an order by credit card please call our office at 302-652-3000 and speak to a Customer Support Representative. Credit card payments are not accepted for orders exceeding $5,000.

Payment terms will be determined upon credit approval.

April 13, 2021

Re: Boise State University Food and Dairy Innovation Center

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing, on behalf of Chobani, to support the proposed Food and Dairy Innovation Center (FDIC) at Boise State University.

Chobani's founding mission is to make better food for more people. We pride ourselves on the positive impact our Chobani Innovation Center and Global R&D Team has in Idaho – and across the nation. Since the opening of our Twin Falls plant in 2013, we have continuously expanded and deepened our roots in the community. We remain firmly committed to investing in Idaho.

To innovate and produce the myriad products in Chobani's portfolio – it takes talented and skilled employees. The FDIC you propose to construct at Boise State University will provide Idaho students an opportunity to gain hands-on experience in dairy research, project management, leadership, and technical skills essential to working for a modern food company. We welcome partnership with the FDIC at Boise State University to meet our needs for well-educated and well-trained future employees – and Chobani's on-going desire to 'hire local'.

We look forward to watching this project come to life – knowing it be good for Boise State University, workforce development, and the state of Idaho.

Sincerely,

Mark Broadhurst
VP Corporate Affairs
Chobani

University of Idaho
College of Agricultural and Life Sciences

Department of Animal, Veterinary and Food Sciences
Agricultural Science Bldg
875 Perimeter Dr. MS 2330
Moscow, Idaho 83844-2330
Phone: 208-885-6345
Fax: 208-885-6420

April 6, 2021

Re: Boise State University Food and Dairy Innovation Center

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to support your proposal to create a Food and Dairy Innovation Center (FDIC) at Boise State University. As an associate professor in the Department of Animal, Veterinary and Food Sciences at the University of Idaho, my research focuses on characterizing genetic variation in mammals and the traits associated with these differences. I use molecular biology to understand the connection between environmental and genetic factors that may influence select attributes of mammals.

In our conversation regarding the establishment of the FDIC at Boise State University, and the potential to collaborate on a project sponsored by High Desert Milk, Hyacinth Proteins, and Lactea Therapeutics, we discussed a number of ways that my work could benefit the study. For example, I am able to identify cows that are likely to produce higher levels of bioactive proteins in their milk. Your work to quantitatively and qualitatively characterize these proteins and evaluate their bioactivity would validate my discovery of genetic markers and environmental factors contributing to the desired protein production.

The FDIC detailed in your IGEM HERC proposal is the kind of research building capacity that would enhance opportunities for us to work together. The dairy projects you propose have the potential to benefit students and researchers at both Boise State University and the University of Idaho. Good luck with the proposal.

Sincerely,
Brenda Murdoch

Brenda M. Murdoch, Ph.D.
Department of Animal, Veterinary and Food Sciences,
Bioinformatics and Computational Biology,
University of Idaho

April 8th, 2021

Re: Boise State University Food and Dairy Innovation Center

Owen McDougal, Ph.D.
Professor and Chair, Department of Chemistry and Biochemistry
1910 University Drive, MS 1520
Boise State University, Boise, ID 83725

Dear Dr. McDougal,

I am writing to support your proposal to create a Food and Dairy Innovation Center (FDIC) at Boise State University. As a Senior Member of the Technical Staff, Organic and AMC Lab Manager, Micron Corporate Laboratories, Micron Technology Inc., I value the transdisciplinary training in chemistry, physics and materials science and engineering provided to students at Boise State University. Over the years I have supported engineering senior design projects in the College of Engineering, and seek to increase participation by chemists in our sponsored student projects for senior design or capstone research experiences.

Micron provides a wide range of internship opportunities for students, and we are always looking to invest in local talent. Boise State University chemistry alumni are employed throughout our process engineering, analytical and clean lab environments. The Food and Dairy Innovation Center that you propose through the IGEM HERC program will serve as a resource for public-private partnership, where senior design students can address challenges to natural resource conservation by creating more efficient processes associated with water and energy utilization. The approach to problem solving, through vertically integrated program (VIP) team activities, will provide critical project management and leadership training for students that benefit us as a potential future employer for those students.

The student training and center professional staff expertise in matters of process engineering, sustainability, high-tech AI-dominated work environments, and state-of-the-art instrumentation will deliver practical hands-on knowledge to enhance the competitiveness of local students for jobs in science and technology.

Sincerely,

Steve Hues, PhD