. **Innovation[X] 2021-2022 Proposal Application**
The School of Innovation and Innovation Partners are calling for proposals for the next round of our Innovation[X] Program, which provides grants that allow multidisciplinary teams of faculty, undergraduates, graduate students, and postdocs to work together to address complex real-world challenges.

Faculty may apply for grants of up to **$20,000** to facilitate year-long projects. The number of grants to be awarded will depend on funding and application levels. Funding begins September 1, 2021.

Additionally, we have partnered with the Mays Innovation Research Center to fund a set of proposals to study the process of innovation itself. Successful proposals for this subset will pursue topics such as, barriers to or preconditions for innovation, the effects of law and policy on innovation, the behavior or psychological requirements for innovation, innovation and health, the social impacts of innovation, international comparisons of innovation, or novel measurements of innovation.

Proposals are due by 11:59 PM on our **newly extended** deadline of **February 22, 2021** and must be submitted using this online form.

NOTE - Only one team leader/faculty member needs to submit a proposal for a given project.

Reminder of Requirements:
- Teams must consist of an interdisciplinary set of faculty members, and must include two (2) faculty members from different colleges/schools.
- Teams must include a multidisciplinary team of 10-20 students, both undergraduate and graduate, from across the university.
- At least 8-10 of these students must be undergraduates.
- The team must include students from at least two (2) different colleges/schools.
- Students must participate in the project for both Fall 2021 and Spring 2022 semesters, with limited exceptions.
- Proposals should demonstrate a team-based approach to a complex problem and include meaningful deliverables.

Please contact Assistant Director Emily Finbow at innovationx@tamu.edu or 979-862-6071 with questions.

. For which tracks would you like your proposal to be considered?

- ( ) Track A - Traditional Innovation[X] Project
- ( ) Track B - Special Track - "Process of Innovation" Innovation[X] Project
- (•) Both Track A and Track B

. Project Title

SageSensors – Precision Agriculture Biosensor Platform

*. Please provide the following information for the Primary Point of Contact for the Project (Project Leader)*

. Prefix

Professor of Practice

. First Name

John

. Last Name

Hanks

. Email Address

john.hanks@tamu.edu

. Phone Number

51296568279

. Gender Identity

- (●) Man
- ( ) Woman
- ( ) Trans Man
- ( ) Trans Woman
- ( ) Genderqueer
- ( ) Non-Binary/Gender non-conforming
- ( ) Not listed above, please specify
- ( ) Prefer not to respond

. Ethnic and Racial Identity

- ( ) Hispanic/Latino/a/x
- ( ) American Indian or Alaska Native
- ( ) Asian/Pacific Islander/Desi-American
- ( ) Black/African American

- (●) White
- ( ) Bi-racial / Multi-Racial (please specify): [ ]
- ( ) Not listed (please specify): [ ]
- ( ) Prefer not to respond

*. Project Information*

. Please provide brief background/context for the issue this project seeks to address. (2,000 character maximum)

This proposal seeks to develop SageSensors that will enable direct measurements of blood biomarkers that are predictive of subclinical (before observable by humans) milk fever in dairy cows using a small implant, the size of a rice grain, and an electronic reader. This technology approach will reduce labor cost and challenges of collecting blood with a syringe, or manually collecting urine or milk samples. Clinical milk fever, hypocalcemia, is a metabolic disease that occurs in 4 to 10% of US dairy cows, with economic losses estimated to be $180M annually. Despite this huge economic costs, clinical milk fever represents the 'tip of the iceberg' as losses associated with subclinical milk fever typically exceed losses due to clinical milk fever by 3- to 4-fold. Unlike existing solutions, SageSensors will enable dairy producers to easily and frequently monitor individual cows for subclinical milk fever on a real-time basis. Milk fever is only the first application. SageSensors is a platform technology that can also detect other subclinical diseases (e.g., ketosis) and may find applications with other feed animals such as beef cattle. Currently, the fundamental implant and reader technology has been approved by FDA for use in humans to continuously measure glucose for the control diabetes. See https://www.senseonics.com Because the existing new chute side technologies require high labor costs to collect biosamples, adoption is likely to be low. We believe an implant with a reader that can be used as a hand held device like SageSensors will have higher adoption. Successful deployment of this technology by the dairy cattle industry could be a game changer as producers will be able to accurately detect subclinical milk fever in real-time, and intervene sooner to improve animal health and wellbeing and reduce the cost of this metabolic disease.

. What are the goals for this project? (5,000 character maximum)

There are four goals to the project: 1. Prototype engineering development – develop an implantable device and electronic reader prototype that can accurately detect decay signals, at a distance, from the implant designed to quantify blood glucose concentrations. The existing FDA-approved system from Senseionics currently uses a patch reader that is placed directly on the surface of the skin. Our preliminary research findings indicate that we will be able to measure blood biomarker signals with the electronic reader positioned approximately 50 cm from the animal, so the reader can be mounted in the field at a water trough or used as a handheld wand. We are modifying an existing implant and reader built to be attached to the surface of the skin from Dr. McShane's lab and research from the biomedical engineering department. Their current technology measures pH, temperature, oxygen, glucose, lactate, and other biomarkers. 2. Intellectual Property – the output from first objective will be intellectual property that will have an impact on digital health for animals and potentially humans as well. We are not aware of a reader implant system that can be used at a distance to detect blood biomarkers that are predictive of metabolic diseases. In addition, there will be additional IP opportunities in to design specific implantable sensor technology to detect other animal metabolic diseases such as ketosis, and to detect the onset of infectious disease such as bovine respiratory disease. 3. Early animal studies – once we have fully developed the prototype system, we will examine the accuracy of the implant and reader technology in beef cattle by comparing measurements from the implant-reader technology against blood concentrations of glucose and lactate measured using "gold standard" methods. Results from this live-animal study will be used do demonstrate proof of concept in seeking to secure future grants and potential investors. 4. Market Validation and Work Flow Validation with Customer Interviews – in parallel with the proposed technology development, we will follow the lean startup methodology and develop a business team consisting of Business and Animal Science undergraduate and graduate students to define the initial target market, value proposition, minimal viable product technical features, pricing, and partner strategy. The goals of this business team will be to perform customer interviews to understand the value and define how the system can be easily adopted to current dairy workflows within our initial target market. Understanding not only the technical barriers but the psychological and workflow barriers for new technology and innovation adoption is key to market success. Customer surveys and market insights will be helpful for SBIR USDA grants or private investors.

. What are anticipated outcomes from this project? (e.g., publications, website, app, data collection for further research/grant) (2,000 characters maximum)

Final deliverable: Investor presentation for seed stage investment or AgTech Incubator Other Deliverables 1. Hardware and software prototype (Eng and Ag team). The prototype will demonstrate the ability to read the gold standard glucose biomarker from more than 50cm. 2. Deployment of the prototype solution (Eng and Ag team). Test prototype on a small number of animals to demonstrate proof of concept. Given our past experiments we believe accuracy level will be within +/- 10% of blood. Absolute accuracy for our target market may not be necessary, data showing a relative drop in the biomarker may be sufficient for a commercial product. 3. Animal data collection experiment (Eng and Ag team). Define protocol for testing prototype system on two animals. 4. Provisional patent applications (Eng and Ag team). Our first target for IP is the implant electronic reader for feed animals. 5. Customer discovery and Workflow interviews (business and Ag team). We plan to use the existing mechanical devices for implanting a growth hormone in beef cattle. We need to understand the dairy workflow and how we can minimize workflow. 6. Value proposition (business and Ag team). We want to test and validate the labor saving value. In addition, we need to validate if a relative drop in the milk fever biomarker is sufficient or do we need to have absolute accuracy. Trending the biomarker and noting a drop in the measurement over time will be a less costly design. 7. First target market (business and Ag team). Evaluate dairy as well as beef cattle markets. 8. Price target (business and Ag team). Validate with customers pricing, product packaging, service, and business model options. 9. Minimal Viable Product (business and Ag team). Given customer feedback and results from our prototype define the requirements for the first commercial product. 10. Estimate of Cost-of-goods at Scale (Eng and business team). Use MVP and customer interviews to estimate COGs at scale.

. Is this proposed project an extension of existing work or a new endeavor? (1,200 character maximum)

This work is an extension of Mike McShane's work from the Biomedical Engineering department. Dr. McShane is the department head and has been working on small implantable fluorescent devices that measure disease biomarkers for more than 10 years. Dr. McShane and his team have more than 10 published articles in this area. In addition, there are two implantable FDA medical devices that use a similar implantable optical approach but are targeted at humans: https://profusa.com/ measures oxygen in blood and https://www.senseonics.com/ measures glucose in blood. Senseonics is publicly traded with an IPO in 2017. In addition, we are leveraging Gordon Carsten's, faculty member from Department of Nutrition and Food Science, expertise and work in nutrition metabolites and biomarkers. Dr. Carsten and his team have more than 10 published articles on nutrition and disease blood biomarkers.

. Is Institutional Review Board (IRB) approval required for this project?

An IRB is not required but an Institutional Animal Care and Use Committee (IACUC) protocol is required for the experimental animal tests. Dr. Carstens will prepare and manage the IACUC protocol and animal experiments. We may have the animal protocol for testing in place as early as Spring of 2021.

. *Team Participants*

. Please list all Team Leaders below (including yourself), including Prefix, Name, Title, and Department/School.

John Hanks, Professor of Practice, Department of Biomedical Engineering Mike McShane, Professor and Department Head, Department of Biomedical Engineering Gordon Carstens, Associate Professor, Department of Nutrition and Food Science

. Do any of the team leaders listed above have plans for a sabbatical or other extended leave away from campus during the 2021-22 academic year? Note: Selecting "yes" will not automatically disqualify a team, but rather will indicate that we need to have a discussion with your team about the nature of the planned leave in relation to the project.

No.

. Please list all Team Contributors below, including Name, Title, and Department/School. *Please exclude anyone you already listed as a Team Leader.*

Amir Zaverh, PhD Post-Doc, Biomedical Engineering Maddison Heck, MBA Texas A&M 2020; Masters of Engineering Student, Biomedical Engineering Keara O'Reilly, PhD student, Nutrition and Food Science

. Do you plan to assign someone other than a faculty leader as a "project manager" for your team (i.e., a graduate student, postdoc, staff person)?

- (•) Yes
- ( ) No
- ( ) Not sure yet

. What would be the ideal composition of team members for this project? What majors, disciplines, skills, backgrounds, or perspectives would you like to have on the team? (2,000 characters maximum)

Maddison Heck, MBA Texas A&M 2020; Masters of Engineering Student, Biomedical Engineering is the overall project manager and will manage the business undergrad team. Amir Zaverh, Post-Doc, Biomedical Engineering will manage the engineering undergraduates. Keara O'Reilly, PhD student, Nutrition and Food Science will manage the Ag team. Three undergraduate teams are required: For us to be successful we need a combination of business, domain knowledge, and engineering/technical skills. Market Validation Team (3 business/entrepreneur undergrads and 2 Nutrition & Food Science undergrads): The customer facing team (business and Nutrition & Food Science team) requires market knowledge or willingness to learn about dairy, beef cattle, and feed lots. Understanding the economics of this market and ability to be take on the customer facing role to identify, coordinate, and perform interviews is key. Animal Protocols Team (2 undergraduates from Nutrition & Food Science): This team will run the animal experiments. They will need to follow IACUC protocol. This team will also need to understand or research USDA regulations and ensure we meet the requirements. Engineering Team (3 engineering undergraduates from biomedical/mechanical/electrical engineering): One for mechanical design, one for electronics, and one for software.

. Will your team also include any external organizations or individuals as either partners, clients, study subjects, beneficiaries of the work, etc.?

There is no official partners. We will primarily be engaging potential partners in our customer discovery and value proposition interviews from dairy farming, feed lots, food science, and animal pharma industries including Zinpro, Zoetis, Eli Lilly, Merck, Cactus Feed Lots, Boehringer Ingelheim . . . We also have contacts at USDA to give guidance.

. *Travel*

. Does your proposal include travel for students beyond Bryan/College Station?

- ( ) Yes
- (•) No
- ( ) Not sure yet

. Where would the team travel?

No travel is needed in these times. Customer interviews and meetings by Zoom.

. When do you anticipate that this travel would take place? (e.g., Fall 2021, Spring 2022, some other academic break, TBD)

. Do you expect that all students selected for the team would be able to travel, or just a select number?

. *Collaboration with Students*

. Ideally, how many undergraduate students would you select to participate on this team? (Numeric responses only, please)

10

. Ideally, how many graduate students would you select to participate on this team?

1

. Ideally, how many professional or doctoral students would you select to participate on this team?

2

. How will you facilitate collaborative inquiry on the team? How often and in what format will the team meet? How will you divide tasks? How you will ensure effective management of the project (e.g., appoint a student as a project manager, assign that role to a faculty leader, etc.)? (2,500 character maximum)

There will be three team leads or project managers led by the three professional, post-doc, an PhD students g listed above. Each team lead will manage the undergrads based on agreed upon management by objective (MBO) tasks. Each project manager will report on status weekly in a management team meeting. Large all hands-on deck meetings will be every 2 to 3 weeks to report out status to all team members. The engineering team will be managed using Agile development methodologies and take inputs from the business and animal experimentation teams. As a professional from industry I have experience in managing business development, R&D, and test teams using Agile development methods. The goal will be to identify the target market, define the minimal viable product features, build a prototype, and collect experimental data for proof of concept. We will use industry tools such as Slack and agile software development/tracking software.

. What might students gain from their participation (e.g., conducting research directly with subjects, contributing to publications, using language skills)? What unique and differentiated learning opportunities would be available for graduate students? (2,500 character maximum)

Students will gain first hand experience in customer discovery, value proposition development, economic cost analysis, industry research, conducting customer interviews, and communication skills using the lean startup methodology. Engineering students will get first-hand experience at building prototype designs and Agile development. Nutrition students will work directly with animals collecting data and learn about USDA regulations and requirements. In addition, cross functional team work between business, agriculture, and engineering teams will be a requirement. Understanding the value that each team member plays will be critical for success.

*. Timeline and Budget*

. Identify the timeline for the project, including start, completion and major project milestones.

*NOTE - You may use the text box or upload a table or file in the next question.*

Milestone 1 (3 mos) - Prototype Design Complete, initial customer Interviews and market validation insights presentation; Milestone 2 (6 mos) - Animal studies complete, data analysis complete; Milestone 3 (9 mos) - Investor Pitch Deck with prototype data, customer discovery insights, value proposition

. Timeline Upload (if needed)

. Total Budget Request (numeric response only, please). As a reminder, the maximum amount that can be requested is **$20,000.**

$19970

. You may upload a budget table here encompassing the categories below, or you may complete the fields below through this form as applicable.

For each item listed below or on your budget table upload, please enter both dollar amount and any relevant notes/justification.

SageSensors Budget.xlsx
9.2KB
application/vnd.openxmlformats-officedocument.spreadsheetml.sheet

. GRADUATE OR RESEARCH ASSISTANTSHIP (PHD) *(Suggested range: $15-18/hour; note: RAships for students in graduate school should include costs for tuition remission and fees)*

Dr. Carstens leveraged funds used for this

. RESEARCH ASSISTANTSHIP *(Suggested range: $12-15/hour)*

$4500

. INSTRUCTION (Teaching) - PHD STUDENT

0

. POST-DOCTORAL OR STAFF EFFORT

20% effort, paid for by Dr. McShanes lab

. UNDERGRADUATE STUDENT STIPEND OR WORK STUDY *(Suggested range: $11-14/hour)*

$11500

. INSTRUCTIONAL, RESEARCH OR OFFICE SUPPLIES

$2000 (animal budget, Dr. Carsten's lab leverage not included)

. COMPUTERS AND MINOR EQUIPMENT

$1950

. TRAVEL - DOMESTIC

0

. TRAVEL - INTERNATIONAL

0

. CONTRACT WORK

0

. MEETINGS - BUSINESS

0

. OTHER - MISC.

0

. Please briefly note below any other sources of project funds. *(Projects that match or leverage additional funds are strongly encouraged. Please note any such funds, awarded or proposed, here so that we understand the comprehensive outlay for the project.)*

This project will leverage Mike McShane's lab funding. His lab will provide a Post-Doc Engineering student that will lead the biomarker design and electronic design with 20% of their time dedicated to the project ~$10,000 in 2021. Gordon Carsten's lab will provide PhD students time to lead the animal studies, IACUC animal testing protocol, and animal management ~$10,000 in 2021.

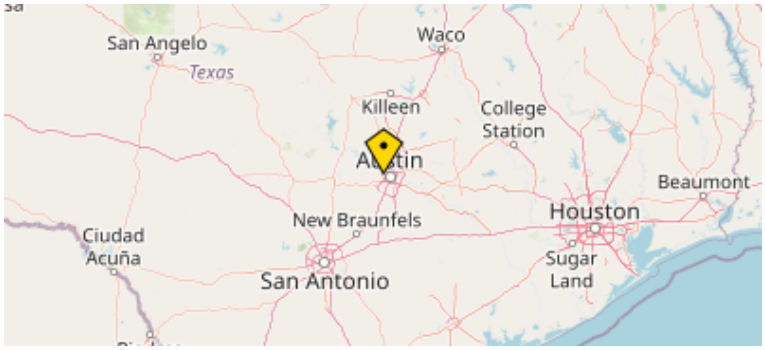
. Please name a Unit/Business Manager who could administer funds for project, if requested. Include their name, email address, and phone number:

Attn: Chris Huff Biomedical Engineering 101 Bizzell St MS 3120 College Station, TX 77843, (903) 655-4328, Christopher Huff <chuff@tamu.edu>

**Location Data**

**Location:** (30.297103881836, -97.818099975586)

**Source:** GeoIP Estimation



| Item | # of Students | # of work weeks | Hours per Week | Pay | Total |
|---|---|---|---|---|---|
| Undergradate Students (Eng, Ag, and Business) | 10 | 24 | 4 | $12 | $11,520 |
| Masters of Enginering Student (RA) | 1 | 30 | 10 | $15 | $4,500 |
| Animal Budget | | | | | $2,000 |
| Instrumentation Software and Hardware | | | | | $1,950 |
| | | | | | $19,970 |