IOWA STATE UNIVERSITY
College of Agriculture and Life Sciences

STEM Programs in the College of Agriculture and Life Sciences

March 2013

Introduction

This document provides selected examples of science, technology, engineering and math (STEM) programs and activities in the College of Agriculture and Life Sciences (CALS) at Iowa State University. It lists precollegiate and collegiate STEM initiatives, including implementing partners. The focus is on programs run or assisted by CALS faculty and staff.

In Support of Precollegiate STEM Development

FFA Annual Leadership Conference. CALS is the host for the annual FFA Leadership Conference. Approximately 4,000 Iowa high school student leaders attend this three-day event and engage in skill-building contests and professional development workshops. CALS Student Ambassadors lead tours of agricultural and life sciences facilities, facilitate workshops for prospective students, organize a barbecue and volunteer many hours at the FFA Career Show.

Iowa 4-H Youth Conference. CALS faculty participate in ISU Extension and Outreach's annual Iowa 4-H Youth conference, providing exposure to a wide range of science fields; for example, 4-H Roundup workshops that bring science into how livestock grow and develop.

George Washington Carver Summer Science Internships. This program, organized and led by CALS, places undergraduate and high school students in labs with faculty mentors for a six-week period. USDA and several corporations partner in the program. The program serves approximately 20 students per year and is poised for expansion pending a grant application to industry. A growing percentage of students who complete the Carver internships decide to pursue science-based careers.

Crop Scouting Competition. CALS organizes an annual one-day crop scouting competition for Iowa youth. The event is an opportunity for high school students to learn crop scouting and principles of integrated pest management, as well as to showcase their scouting abilities in corn and soybeans. Teams gather information, solve problems and make decisions related to crops and their pests with consideration for the environment and economy. Students complete a knowledge test and a crop scouting field exercise. The competition is conducted by the ISU Integrated Pest Management Program with support from the Iowa Soybean Association and Pioneer Hi-Bred International, Inc.

Integrated Pest Management Curriculum. ISU's Integrated Pest Management program provided a set of educational materials to agriculture teachers at 234 high school and community colleges in 2011. The resources are used by instructors to help prepare students for the ISU's annual Crop Scouting Competition. The resources distributed to the schools included a 14-part IPM curriculum on topics such as corn and soybean growth and development, weed science, pesticide resistance and plant disease management; copies of ISU Extension and Outreach field guides and other pest-related publications; and an interactive learning module called "Scouting Fields."

Destination STEM. CALS faculty and staff in agricultural education and studies and in agronomy are co-directors of a new strategic initiative funded in 2013 for $448,000 by the ISU Vice President for Extension and Outreach. Led by Jay Staker, Destination STEM will establish infrastructure to improve connections between ISU with the Iowa K-12 community and offer professional development to support teachers, staff and volunteers. Campus visits, remote programming, professional development opportunities and a mobile unit to deliver programs are among Destination STEM's goals. CALS and other university units will support remote programming and offer on-campus programs.

FFA Soil Judging Competition. CALS has hosted the annual FFA State Soil Judging Contest for more than 30 years. About 30 high school teams (120 students) participate and test their knowledge of soil science and management. They compete to represent Iowa at the International Land Judging Contest. Sponsors have included the Iowa Corn Promotion Board, Professional Soil Classifiers of Iowa, Iowa FFA Foundation, Iowa Department of Education, USDA Natural Resources Conservation Service, the ISU agronomy department, CALS and ISU Extension and Outreach.

FFA Career Development Event in Agricultural Mechanics. ISU faculty, staff and graduate students in agricultural education and studies and in agricultural and biosystems engineering assisted more than 120 FFA members from 27 Iowa high schools in an event held last year at the college's Ag450 Farm. The FFA students participated in several events that included mathematics, problem-solving, engineering and teamwork. High school teachers took several learning activities back to their schools for use in their educational programs.

FFA Product Development Competition. For more than 10 years, the Department of Food Science and Human Nutrition has sponsored and hosted the annual FFA Product Development Competition for student teams from around the state. More than 60 students take a general knowledge test designed to determine their understanding of basic principles of food science and technology. Student teams present a product developed in response to a specific scenario. Students also complete individual practicums in food safety and quality, food safety and sanitation, and sensory evaluation.

FFA Crops Judging Competition. For many years, CALS has hosted the annual FFA State Crops Judging Contest. About 30 high school teams (100 students) participate in both individual and team portions of the competition. Students test their knowledge by identifying seeds, plants and insects. They take a written exam focusing on problem-solving and decision-making on crop topics. In team events, the groups address seed and planting problems and soil fertility problems.

Food Science and Human Nutrition Day. This semi-annual event brings high school students and their families to campus for a day to learn about studying food science and human nutrition at ISU. Guests interact with faculty and college students to understand ISU's programs and opportunities once they graduate. Faculty conduct workshops similar to what a student majoring in food science and related programs may encounter in a lab. The event draws between 60 and 80 prospective students and family members.

Professor in the Classroom and Other Visits that Support Middle School and High School Programs. CALS faculty visit high school science classes to present information about the world of science. They also conduct annual workshops for agriculture teachers. At the annual Norman Borlaug Inspire Education Day in Cresco, Iowa, CALS faculty present on scientific topics to more than 250 young people. Graduate students take a traveling biodiesel production module to various sites to demonstrate the science of biofuels. CALS Student Ambassadors visit high schools throughout the state to introduce prospective students to agricultural and life sciences opportunities in the college.

World Food Prize Iowa Youth Institute. CALS, with support from ISU Extension and Outreach, organized the inaugural event in 2012 for this institute, which will become an annual event. This program demonstrates the connection between science and technology and the grand challenge of combating global hunger. The Youth Institute is an important opportunity for the College to promote STEM education. Through the Youth Institute, CALS promotes STEM by introducing high school students to strong role models in the college. They are connected to faculty with expertise in international food security issues — and also to the college's own students who share a passion for global issues. The hope is that CALS faculty, staff, students and partners will inspire them to pursue STEM to provide hands-on solutions to tough global challenges. Approximately 140 high school students took part in 2012 and 200 are expected in 2013.

High-Tech Welding, Engine Short Courses. The Department of Agricultural Education and Studies offers a series of spring and summer short courses that support STEM education by honing the technology skills of high school instructors. Participants primarily are teachers of high school agricultural education and industrial education courses. In 2013, four courses focus on state-of-the-art welding and metal-cutting processes. Another course offered is a three-day small engines school, from theory to hands-on assembly and disassembly.

Science Bound. Science Bound is Iowa State University's premier precollege program to increase the number of ethnically diverse Iowa students who pursue agricultural, scientific, technical, engineering and mathematics degrees. The program draws students with potential from middle schools and high schools in Des Moines, Denison and Marshalltown. For example, the Microbiology Club participated in Science Bound weekend visits by providing hands-on activities in labs.

State Science + Technology Fair of Iowa. CALS is an overall sponsor of the annual science fair hosted by ISU. CALS provides scholarships directly to top-rated

participants, while CALS faculty and staff volunteer their efforts as judges. A record 620 high school and middle school students participated in 2012.

Program for Women in Science and Engineering. CALS is a sponsor of PWSE's Summer Internship Program. The students conduct a project under the direction of a mentor and present results at a poster session at the conclusion of the program. PWSE, a university-wide program, supports students in four colleges (Agriculture and Life Sciences, Engineering, Human Sciences, Liberal Arts and Sciences) in more than 50 STEM majors.

Livestock Judging Camps. The camps include sessions for young people to learn about genetic prediction tools like expected progeny differences, or EPDs, which are used to measure performance in animals.

STEM Education and Outreach in Biotechnology, Molecular Biology and Microbiology:

- **Symbi**. Symbi, known as "Iowa's GK-12 Program," is the only program of its kind in the state and part of a National Science Foundation effort to put graduate students studying STEM into Iowa K-12 classrooms. The leader of the grant proposal that launched Symbi is a CALS faculty member in biochemistry, biophysics and molecular biology. Faculty, staff and graduate students in CALS and from around campus serve as program leaders, research advisors and fellows. Symbi is a chance for ISU students to inspire school students and their teachers with the excitement and importance of science, engineering and university research.

- **Biotechnology Summer Workshops.** CALS faculty in agricultural education and studies develop and evaluate the assignments of participants who take ISU's Office of Biotechnology summer workshops for graduate credit. Participants are graduate students, high school teachers and extension professionals. Educators attend the workshops to strengthen and update their STEM-based curricula with modern content, techniques and activities in biotechnology, while earning professional development or ISU graduate credits. For participants who want graduate credit through CALS, agricultural education and studies faculty work with them on independent study projects that often involve developing learning activities or curriculum materials for teaching learners about biotechnology.

- **Plant Genomics Education Outreach**. The Department of Ecology, Evolution, and Organismal Biology has offered a program for K-12 teachers for nearly a decade. The program, made possible through efforts of CALS and Liberal Arts and Sciences faculty and staff, includes offering biology teachers from seventh grade to 12th grade hands-on research opportunities in molecular biology, biotechnology and genomics, under the mentorship of a distinguished group of faculty. This has been funded entirely by the National Science Foundation. Details: http://www.plantgenomeoutreach.eeob.iastate.edu/index.htm.

- **Microbiology High School Workshop.** An all day learning event for high school students, the workshop is led and sponsored by the Undergraduate Microbiology Club. Up to 60 high school students participate in hands-on activities and hear from scientists. Students participate in a model for the spread of disease, diagnostic tests for organisms and a "murder mystery" that is solved using antibody techniques and DNA electrophoresis.

- **Des Moines Central High School Biotechnology Class.** This high school class, taught by award-winning science teacher Kacia Cain, interacts with ISU's microbiology program. For nearly 20 years, ISU has supplied equipment such as media plates for a microbiology unit. The ISU microbiology program hosts up to 18 of the high-school students to perform laboratory diagnostic tests to diagnose case studies they have been assigned. ISU faculty participate in additional visits to the biotechnology class during the academic year to give presentations on food safety, bioterrorism and other topics, as well as evaluating student presentations.

- **Veishea Microbiology Display**. The display is built and staffed by the Undergraduate Microbiology Club. The theme, "Microbiology for All Ages." includes a giant walk-through microbe, "Eat Like a Microbe" served in petri plates, posters and displays. This annual event has parents returning every year with their children as well as high school instructors who bring Science Bound students. The target audience is pre-school through high school.

- **Science Night at Elementary Schools.** The Microbiology Club participates in local Ames grade school Science Nights for kids from kindergarten to fifth grade.

- **Glo Germ Educational Units.** The microbiology program has two demonstration units that use "Glo Germ" lotion to detect microbes on hands. The units are loaned to faculty or staff for demonstrations in local grade schools.

<u>STEM Education and Outreach in Natural Resource Ecology and Management and Entomology:</u>

- **Insect Zoo.** The Insect Zoo is an outreach program developed to foster an appreciation of insects through K-12 visits, tours of the ISU Insect Zoo facility and specialized opportunities for youth and precollegiate audiences. Participants learn about interrelationships among diverse insect groups, their important role in life on earth and gain an appreciation for biological disciplines.

- **Youth Fishing Opportunities.** Led by ISU's extension fisheries specialist, three programs were conducted in Iowa during summer 2012 including groups of middle-school boys and girls, youth from the Science Center of Iowa and 4-H groups.

- **AgDiscovery.** AgDiscovery began in 2010 and helps teenagers learn about careers in veterinary medicine, animal science, laboratory technology and

wildlife ecology. Students live on campus and learn from professors, USDA scientists and local agricultural producers and organizations. The program is conducted through a collaborative agreement between ISU and USDA's Animal and Plant Health and Inspection Service. Students gain experience through hands-on labs, workshops and field trips. Team-building activities and diversity workshops build important life skills. Led by ISU's wildlife extension specialist, this program provides training to 16 high school students annually.

- **Iowa Association of Naturalists Workshops**. Sessions led by ISU's extension wildlife specialist are held once or twice a year at the Iowa Association of Naturalists' workshop to help county conservation board naturalists around the state be better prepared to deliver science to students of all ages.

- **ISU's Student Chapter of the National Association for Interpretation.** This student chapter presents programs at school science fairs and science nights and helps with events around the state, including iExplore STEM, a project of the State Hygienic Laboratory and the Health and Human Physiology Department at the University of Iowa.

- **Iowa Envirothon Teams.** ISU Extension and Outreach faculty (wildlife, forestry and fisheries) in the Department of Natural Resource Ecology and Management have helped to train high school student teams involved in the statewide Iowa Envirothon, as teams prepare for the national Envirothon competition.

Collegiate STEM Programs and Our Partners

Science With Practice. This is a CALS experiential learning and work program for undergraduate students in agriculture and related sciences. The program provides meaningful, paid, on-campus internships for undergraduate students who also earn class credit for what they learn. Students work closely with faculty and staff on specific projects and work assignments. Hundreds of Science With Practice students majoring in agriculture and life sciences fields have benefited from working with faculty and staff mentors in nearly every department and unit in the college.

Undergraduate Research. Hundreds of CALS undergraduates are hired to assist in faculty research. For some, this is their first exposure to research and to role models in research. Pathways to graduate studies are often illuminated through these experiences. For example, in animal science many undergraduates work in research laboratories gaining experience; they simply call it "Hands on Science Experience."

National Science Foundation Research Experience for Undergraduates. The National Science Foundation has provided funds to CALS to support several Research Experience for Undergraduates programs. These include sustainable production and processing systems for biomass-derived fuels, animal genetics and others. CALS faculty lead a USDA National Institute for Food and Agriculture-funded Coordinated Agricultural Project entitled CenUSA Bioenergy, which runs a similar program. In these programs, student participants select project areas that match their academic

background and interests and spend eight to 10 weeks of the summer at Iowa State working on hypothesis-driven research projects.

STEM Connections with Iowa Community Colleges. CALS hosts an annual meeting with community college representatives to work on curriculum in STEM areas, ensure articulation programs are up to date and help students smoothly transition from community colleges to ISU. The ISU-community college group aspires to be a national model by working closely on an integrated system of science and technology education in the fields of agriculture and natural resources. In 2012, the group held its second annual Statewide Agricultural Sciences Articulation and Partnership Workshop that focused on curricula in agronomy, horticulture, animal science, natural resources and agricultural business.

ISU ADVANCE. CALS works in conjunction with the ISU ADVANCE program and the national NSF ADVANCE program to enhance the recruitment, retention and advancement of women faculty in STEM fields. ADVANCE goals are to increase the participation and advancement of women in academic science and engineering careers and make Iowa State an optimal environment for all faculty in STEM.

Natural Resource Ecology and Management Outdoor Skills Weekend. The Department of Natural Resource Ecology and Management partners with the Iowa Department of Natural Resources and the 4-H Center to offer an annual Outdoor Skills Weekend. It focuses on recreation and working outdoors and serves as an introduction to the North American Model of Conservation. The event, held in 2011 and 2012, has been expanded into a one-credit college class (NREM 207) that will include further exploration of the current North American Model of Conservation and its continuing evolution. Thirty undergraduate students participated in 2012; the course can serve up to 40 students each year.

Collegiate Soil Judging Competitions. CALS undergraduate students participate in regional and qualifying national competitions. The team (a maximum of 15 students) competes together and its members also compete individually. Students are required to review the physical properties of soil and how the soil is changing. They calculate groundwater flow, water-holding capacities, erosion rates and slopes of soil. The judging team gives students hands-on learning and emphasizes the importance of working together as a team.

Collegiate Crops Competition. CALS undergraduate students test their knowledge in this competition in several ways. They take an exam to test their agronomic math skills with problems including fertilizer blending, sprayer calibration and seeding rates. They identify plants and seeds in their vegetative, reproductive/flowering and seed forms. They identify insects, diseases and agronomic equipment. Hands-on learning is an important component of these events.

Institute of Food Technologists Product Development Competition. Teams made up of ISU graduate and undergraduate students conceive of a food product and take the idea through to marketing. In three of the last five years, an ISU team has advanced to the final round of the national IFT Product Development Competition. In February 2013, an ISU team will compete at the IFT Wellness Conference.

Institute of Food Technologists College Bowl. ISU students have participated in regional IFT College Bowl competition since it began in 1985, with some ISU teams going on to national competition. This "quiz bowl"-type regional and national competitions test students' knowledge of food science and technology, history of foods and food processing, food law and general food-related information.

Collegiate Dairy Products Evaluation Competition. ISU graduate and undergraduate students compete individually and as a team to judge the sensory properties of six dairy categories: milk, butter, cheddar cheese, vanilla ice cream, cottage cheese and yogurt. Students learn to identify sensory properties and defects that may occur within dairy foods.

Majors in Agriculture and Life Sciences

All undergraduate majors in CALS provide a science and technology foundation for the future work force. Here is a brief description of each major.

Agricultural Biochemistry. This curriculum combines training in the biological and physical sciences and mathematics with studies in agricultural sciences. The major provides preparation for advanced study or employment in biotechnology and other areas of agricultural science in which biochemistry is of fundamental importance.

Agricultural Business. In-depth course work covers topics such as the marketing of agricultural products and services, the managing of farm and agribusiness operations and the lending of credit to agricultural firms. In addition, students will take courses in technical agriculture, agricultural policy, accounting, business finance, computerized record keeping, business marketing, agricultural law and resource economics.

Agricultural and Life Sciences Education. This curriculum combines food, agriculture and life sciences with social sciences and communications. Some students choose the teacher certification option while others choose the communications option. Graduates enter careers that include working with people in agriculture, such as education, extension, agribusiness and public agencies.

Agricultural Studies. This curriculum covers a broad spectrum of agriculture and life sciences with the flexibility that permits students to customize the major. Students can choose an area of emphasis such as farm management, agronomy, agricultural law, agricultural systems and technology, and international agriculture.

Agricultural Systems Technology. AST prepares men and women for careers in agricultural machinery industries; construction companies; governmental agencies; grain, feed, seed, fertilizer and chemical businesses; production agriculture; and environmental organizations. AST teaches skills in decision making, problem solving, creative thinking, communications and technology

assessment. Courses include microcomputers, water quality, energy, electrical safety, fluid power systems, precision farming, electrification, animal production and manure management systems, machinery management and tractor power, as well as business, sciences, mathematics and communications.

Agronomy. Agronomy integrates the science and practical application of crop production, soil management and climatology in the production and utilization of food, feed and fiber within an environmentally sound system. Majors can choose crop management and business, agroecology, soil and environmental science and plant breeding and biotechnology.

Animal Ecology. This curriculum focuses on the relationships of terrestrial and aquatic wildlife to their environment and applying knowledge to wildlife conservation and habitat management. Graduates of this biological science curriculum pursue career opportunities with public and private natural resource and environmental agencies, educational institutions and businesses. Curriculum emphases may be taken in wildlife biology, fisheries biology, aquatic sciences, interpretation of natural resources, or preveterinary and wildlife care.

Animal Science. This curriculum focuses on the understanding of the life cycle of companion and production animals, through study of the fundamentals of behavior, growth and development, lactation, genetics and breeding, nutrition and reproduction. The curriculum integrates enterprise management and marketing aspects of the animal industry. In addition to animal management, career options include agribusiness, biotechnology, dairy foods and meat science, pet food and feed industry, marketing and research.

Biology. This academic program offers the flexibility to accommodate a range of career goals in areas like plant biology, zoology, genetics, cell and molecular biology, ecology and evolutionary biology. This major prepares students for graduate school or further study in human medicine, veterinary medicine, dentistry, optometry, physical therapy or pharmacy. Students who are interested in marine biology or tropical studies can participate in summer programs at affiliated institutes.

Culinary Science. This is an interdisciplinary degree combining a strong food science foundation with basic culinary skills development. Students study fundamental sciences including chemistry, organic chemistry, biology, microbiology and biochemistry, as well as courses in quantity food production, fine dining management, and food safety and sanitation.

Dairy Science. This curriculum provides training for a variety of career opportunities in agriculture, particularly those involved with dairy cattle or associated industries. Although many graduates own or manage dairy operations, the majority find employment in such career areas as agribusiness management, biotechnology, dairy foods manufacturing, marketing or research.

Dietetics. This is an undergraduate didactic program, approved by the American Dietetic Association. Graduates are eligible to apply for admission to dietetic

internships/supervised practice programs. Upon successful completion of the experience program, graduates are eligible to take the national examination to become a registered dietitian.

Diet and Exercise. This program combines the study of nutrition and exercise science. The program allows students to concurrently complete courses for the bachelor of science degree while also completing courses and a thesis for a master of science degree. Careers include work with cardiac rehabilitation programs, school nutrition and wellness programs, corporate health programs, health clubs, public health programs and clinics, preventative health programs and sport enhancement programs.

Environmental Science. CALS and the College of Liberal Arts and Sciences offer this integrated approach to the study of environmental systems. The curriculum is designed to prepare students for positions of leadership in this rapidly changing discipline. Majors complete foundation courses in chemistry, biology, physics and mathematics, plus a major consisting of an integrated core of environmental science courses and additional advance course work from departmental offerings.

Food Science. Food science is a discipline in which the principles of biological and physical sciences are used to study the nature of foods, the causes of their deterioration, and the principles underlying the processing and preparation of food. It is the application of science and technology to the provision of a safe, wholesome and nutritious food supply.

Forestry. This program provides training in forest ecosystems, wood technology, forest resource management, agro-forestry, urban and community forestry, biodiversity and water quality. It includes a fall forestry course including a 16-day off-campus forestry camp held at one of several locations across the country. The five options that are available in the program are urban and community forestry, forest ecosystem management, sustainable materials science, interpretation of natural resources and natural resource conservation and restoration.

Genetics. This curriculum is based on preparation in biology, chemistry, biochemistry and genetics. Students receive an understanding of modern methods of genetic engineering and are prepared for jobs in industry and for further work in the biological sciences, including graduate, veterinary or medical school.

Global Resource Systems. This is an interdisciplinary major that emphasizes global and cross cultural engagement while equipping students with strong technical competency in a resource area of their choosing. This major prepares students to work on complex global resource issues through leadership positions in international non-governmental organizations, global businesses, government agencies engaged in international trade and development, and globally engaged foundations, educational institutions and volunteer organizations.

Horticulture. This curriculum focuses on turfgrasses, nursery crops, greenhouse crops, fruits, nuts and vegetables. Also, it involves landscape horticulture and management, interiorscaping, botanic garden management, public garden

management, plant breeding and molecular biology. Course subjects vary from understanding the mechanisms of the cell to production and management of horticultural crops.

Industrial Technology. This curriculum prepares students for professional positions in technical management, applications, development and engineering in industry, business or government. Options within the program focus on manufacturing technology and occupational safety technology.

Microbiology. This curriculum focuses on the study of the biology of microorganisms and how they interact with their surroundings. Microbiologists work in areas related to agriculture, the environment and medicine.

Nutritional Science. This curriculum offers students a strong basic science and general education that enables them to gain knowledge and skills necessary to work in research laboratories. This major also can serve as a preprofessional program for medicine, dentistry, veterinary medicine or graduate study in nutrition or biological sciences.

Environmental Studies (secondary major). This curriculum deals with the relationship between humans and nature, or between humans and natural systems. The curriculum is designed to give students a broader appreciation of the environment and an overview of critical environmental issues.

International Agriculture (secondary major). This curriculum provides students with a global perspective. Students will prepare for careers overseas or for careers with organizations with global interests.

Seed Science (secondary major). The seed science program is designed for students with career interests in one or more aspects of the seed industry. Areas of study include: seed production, conditioning, pathology, physiology, quality control, and marketing, as well as seed plant designs.

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