# Bakery Science & Management: Bachelor – CIP Code – 01.0401 Feed Science and Management: Bachelor – CIP Code – 01.0401 Milling Science & Management: Bachelor – CIP Code – 01.0401

The Department of Grain Science and Industry (GSI) in the College of Agriculture (CoA), Kansas State University offers undergraduate majors in Milling Science and Management (MSM), Baking Science and Management (BSM) and Feed Science and Management (FSM).

*Mission Centrality and Uniqueness.* The mission of the GSI programs is to educate students and professionals, conduct innovative research, transfer new technologies and knowledge, offer high-quality outreach programs and services. The department's historical and current mission is highly aligned with the University's three-fold mission of *research, teaching* and *outreach.* Faculty activities in the three domains are synergistic. Research and outreach activities serve to reinforce and add relevance to the formal instructional program. Likewise, the efforts required to deliver an effective degree or research program provide fundamental information and skills necessary to assure high quality outreach. Thus, our degree programs are unique. No other institution in the state, region or nation offers Baccalaureate degrees in Milling, Feed and Baking Science. Being the breadbasket of the nation, our degrees are central to Kansas, where high percentage of the gross state product is provided by food/grain-related industries.

*Quality of the Faculty*. Currently (Fall 2017), there are 20 faculty members (11 tenured, 2 tenure-track, and 8 non-tenure track). Department faculty members are leaders in all facets of the cereal foods and food science, food/grain processing industries. They serve as invited lecturers in regional, national and international courses. Faculty members contribute regularly to refereed scholarly journals and scholarly books. They are called upon to serve as technical consultants, grant review panel members and scholarly journal editors. Of the 20 faculty members at the rank of instructor or above, 13 faculty members are Ph.D. degree holders, 14 have had multiple year, full-time, professional experience (~160 years combined experience) in the private sector. This experience fosters realism and credibility in the classroom that helps students understand the world beyond the classroom and allows faculty the continuing close interaction with industrial colleagues. One indicator of faculty quality is the awards won. Select GSI faculty achievement and recognitions are: University Distinguished Professorships (2), Endowed Professorships (4), Industry supported faculty positions (3), IFT Fellows, AACCI Fellows, AACCI awards (Excellence in Teaching, Scott-Blair Memorial Award, Geddes Memorial Lectureship, Young Research Scientist Award), College of Agriculture awards (David Mugler Excellence in Teaching, Outstanding Graduate Faculty), Gamma Sigma Delta awards (Outstanding Teacher, Outstanding Graduate Faculty), Commerce Bank awards (Outstanding Undergraduate Teaching, Distinguished Faculty), and several other highly competitive awards including Andersons Cereals and Oilseeds Award of Excellence, Certificate of Outstanding International Educator, Entomological Society of America Entomological Foundation Higuchi Research Achievement Award, Bio-environmental Polymers Society Lifetime Achievement Award, National Academy of Inventors membership, North American Colleges and Teachers of Agriculture Educator Award, Scientific Research Society Outstanding Senior Scientist Award.

*Quality of Degree Programs.* Students in our majors develop skills in the basic sciences of math (calculus); chemistry (inorganic, organic, and biochemistry); physics; biology, microbiology, plus aspects of grain processing, safety, quality, and regulatory issues. Entering freshman ACT scores consistently average around 25 for BSM and MSM, and 23 for FSM, well above the University averages. This is not surprising because GSI is regarded as a department that has higher requirements in mathematics and sciences than some other majors in the CoA. Because it is a thoughtful combination of fundamental knowledge and actual hands-on experience, the department's curricula have a unique and positive effect on its students. The department's facilities allow the curricula to train students in the processes of the cereal grain and cereal food industries from bench top to full pilot scale operations. Preparing students for small scale operation utilizes department's bench top and laboratory scale systems in baking, feed manufacturing, wheat flour milling and extrusion. Our pilot scale production

facilities for flour milling, extrusion and feed milling complete this training. Internships are additional opportunities to work hands-on in a professional environment and gain real-world experience. Although, our curricula require one external/industrial internship for all students, at least 80% of our students have two-or-more (paid) internships experiences. Increasingly more students are able to secure an internship even after their first year. Every fall semester, we host numerous industry representatives from 20+ companies who schedule 1-3 day campus visits to conduct interviews with our student for the upcoming summer internships and/or open positions. The combination of fundamental, pilot scale and actual industrial experience before graduation produces a student uniquely qualified for future employment in their chosen discipline. Feedback from the CEOs and the owners of milling, feed and baking companies suggest strong satisfaction with our students and their ability to be successful for long-term employee.

*External Demand.* By any measure, students who graduate with a B.S. from the department are in very high demand. Students regularly return from summer internships with offers for full-time employment upon graduation (87.6% employed; 10.6 further education). It is not uncommon for students to have multiple offers. In fact, if the occasional self- imposed decisions are excluded, student placement is effectively 100%. Starting salary packages consistently rank at the top of the COA and among the top of the University (including relocation allowances and, occasionally, signing bonuses of up to 10% of the base salary). The outlook for employment continues to be bright as most companies report that current graduation rates are not keeping pace with their needs. This situation has contributed to the rise in starting salaries, commonly \$55-75K, depending upon specific major.

*Service Provided to the Discipline, the University and Beyond.* The service provided by our degree programs and our graduates are diverse. Within the university, our classes are taken as optional courses by a diverse set of agriculture majors. At least one third of the department's current faculty received their undergraduate and/or training in the Grain Science. Beyond the university, the department's graduates occupy positions of responsibility and authority in all aspects of the cereal processing and cereal foods industries nationally and internationally, the federal government (e.g. USDA/ARS) and educational institutions (e.g. American Institute of Baking), and include vice presidents of research & development, national and international production managers, facilities directors etc. In addition to the academic program developing human capital for the grain industry, GSI faculty provide cutting edge research, new technologies and highly valued extension/outreach to companies in Kansas and around the globe. The department's faculty members are frequent invited participants at national and international technical or training courses as well as at educational opportunities for international trade teams. It has been observed, accurately, nearly all cereal/grain based products have been touched at some point in their development and production by a KSU-GRSC graduate.

**Cost Effectiveness.** The Grain Science and Industry department is unique in that it is the only program of its kind offering majors in Milling Science and Management, Feed Science and Management and Bakery Science and Management. These programs are highly interrelated, sharing faculty and coursework requirements. The majority of faculty in the department have funded appointments in the Agricultural Experiment Station, and for many, the teaching portion is the minor component of the funding. Of the 20 faculty positions, although 5.0 FTE is assigned in teaching, these full-time faculty with minor teaching FTEs are heavily involved in and contributed to our teaching programs. As a department (CIP Code 01.040) the Board of Regents' standards for numbers of majors, degrees conferred, faculty with terminal degrees, and average ACT composite scores of students are exceeded. The average undergraduate student credit hours (SCH) produced in GSI as a percentage of the CoA has been around 7.5% while the GSI percentage of instructional expenditures was 8.2% during that same time frame. Overall, given the high percentage of classes that have laboratories, the high cost of maintaining specialized teaching facilities, and the support of a strong graduate program, the programs higher than average costs per credit hour generated are readily justifiable. Additionally, this program is highly visible and critical to the grain industries which are critical to the Kansas and regional economies. This is perhaps best evidenced by department's industry-funded scholarships (>\$200,000 per year), Professorships (>\$200,000 per year), feed mill (\$16M), flour mill (\$10.5M) and International Grains Program (IGP) facility.

## Food Science: Bachelor, Master's, Doctorate - CIP Code - 04.0601

*Mission Centrality and Uniqueness*. The mission of the Food Science and Industry program is to provide education, service, and leadership to Kansas, national and international stakeholders, through development, interpretation, and dissemination of knowledge pertaining to quality, quantity, safety and biosecurity of the U.S. food production system. The Food Science and Industry program offers both on-campus and online degree completion opportunities. Students select between three options: 1) Science and pre-professional (medicine, veterinary, pharmacy, graduate school, etc.) option, 2) Food Business and Operations Management option, and 3) Technology option (mainly our online degree completion program). K-State has identified the safety and security of the food supply as one of its highest areas of priority. The B.S. degree in Food Science and Industry aligns tightly with this centralized mission, as the only one of its kind in the Kansas Board of Regents system. Recent reports from the Kansas Department of Agriculture indicate that ~43% of the Kansas economy is based on agriculture; thus, the Food Science and Industry program is critical to Kansas as well. From 2011 to 2016, food science has represented the 3rd largest undergraduate enrollment in the College of Agriculture.

The interdisciplinary Food Science Graduate Program was established over 50 years ago to educate and train post-baccalaureate students for careers in the various areas of food production, processing, quality, regulations, safety, and product development. The program seeks to promote research, scholarship, and critical thinking amongst our students through coursework and cutting edge research critical to the food system using both synchronous and asynchronous learning. The Food Science Graduate Degree program at Kansas State University is unique within the state and provides Kansas students with the option of attending a "local" university, paying in-state tuition, and receiving an education in Food Science. The Masters Distance education degree component provides educational opportunities and enhancements for food science professionals currently working in industry and government. The interdisciplinary nature of the program permits students to tailor their program of study to suit a particular research field. Many students in related disciplines (cereal science, meat science, bakery science, sensory science, and nutrition) have taken advantage of the unique interdisciplinary program to enhance their educational experience. The Food Science Graduate Program works closely with stakeholders to ensure that students are educated to address complex scientific issues across the global food system and are prepared for future leadership positions within the food industry and allied industries.

*Quality of the Faculty*. Eight tenure-track faculty and two non-tenure track faculty are directly involved with the Food Science undergraduate program. Combined, these faculty represent 5.85 FTEs in teaching and the remaining 6.15 FTEs assigned in K-State Research and Extension. All faculty have PhDs as a terminal degree. One indicator of faculty quality is the awards won in the last 5 years. During 2008 to 2016, these faculty have amassed 12 awards, from the University to international arenas for teaching, advising and research based on their work. Another quality indicator is the number of students that choose the major. From 2008 to 2011 the average number of food science undergraduates receiving B.S. degrees was 25 students/yr.; in contrast with 2014 to 2016 when the average number of food science undergraduates receiving B.S. degrees was 46 students/yr.

Food Science graduate faculty members are located in five K-State colleges, with the bulk of the programs in Call Hall, part of the Animal Sciences and Industry Department. Other departments include: Agriculture Economics, Animal Sciences and Industry, Biochemistry, Biological and Agricultural Engineering, Chemical Engineering, Communications, Diagnostic Medicine/Pathobiology, Entomology, Geography, Grain Science and Industry, Nutrition, Dietetics and Health. The program is coordinated by an interdisciplinary advisory group of faculty as defined in the program By-Laws. This committee contains nine voting members chosen every three years on a rotating basis by elections in late May with terms starting July 1st. The graduate program chair is elected every three years by faculty vote in late May. For the last 15 years the program has been bolstered with

financial support and part-time staff provided by the Food Science Institute in conjunction with the College of Agriculture. The Food Science Graduate faculty is composed of 45 members, and three adjuncts. Our faculty have established track-records of obtaining grants and funding from a variety of sources including, the National Dairy Council, North American Meat Institute, National Pork Board, FDA, USDA-NIFA, Kansas Department of Agriculture, AIB International, and various companies such as McCormick, Corbion and Toshiba Foods. Food Science graduate faculty members publish research articles in respected peer-reviewed journals and many serve as editors of these same journals. The quality of the faculty is the major reason the doctoral program was ranked ninth out of thirty schools by the National Research Council (NRC) in their 2013 report "A Data-Based Assessment of Research-Doctorate Programs in the United States." The faculty have received numerous awards and have held, or currently hold, prestigious leadership positions in the profession, including; Milk Industry Foundation Teaching Award, ADSA President, IFT Food Microbiology Chair, IFT Food Chemistry Chair and Food Toxicology Chair, AMSA Signal Service Award, Gamma Sigma Delta Distinguished Faculty Award, IAFP Elmer Marth Educator Award, USDA National Advisory Committee on Meat and Poultry Inspection, National Committee for Employer Support of the Guard and Reserve, and K-State Woman of Distinction Award.

Quality of Degree Programs. Many students use the Food Science and Industry degree to complete preprofessional requirements for veterinary, medical, pharmacy, nursing, and dental schools while also preparing for challenging careers in the food industry. Students in this major must have skills and interests in the basic sciences of math (calculus); chemistry (biochemistry, physical and organic); physics; biology, and microbiology, plus aspects of food chemistry, processing, safety, nutrition, quality and regulatory issues. The curricula for the degree options are challenging, but students that desire to work in the applied sciences are attracted to this major. Entering freshman ACT scores consistently average ~25, well above the College and University averages. Enrollment in the food science and industry program has grown substantially over the past 8 years – between 2008 and 2014, the number of students enrolled in the program, both on-campus and online, more than doubled (increased 118%). About 20% of all undergraduates enter graduate school or some professional schools for additional professional development upon graduation; virtually all of the remaining students find jobs in the foodrelated industries, if desired. Using the six-year cohort (2010 to 2016) and the mechanism K-State uses for graduation rates, the 6-year graduation rate for the 2010 cohort of Food Science students was 81.8% compared with 69.5% for the College of Agriculture and 66.4% for the University. Moreover, the program is nationally recognized and approved by the Institute of Food Technologists (IFT). From 2011 to 2015, undergraduate students received 21 IFT-sponsored scholarships. These scholarships are highly competitive and considered prestigious in the food industry. For 2018, college factual rated K-State's food science undergraduate program as number 11 in the nation.

The Food Science Graduate Degree Program is recognized by the Institute of Food Technologists (IFT), an international non-profit professional organization for the advancement of food science and technology worldwide. In 2013, a survey by the National Research Council (NRC) ranked our doctoral food science program ninth in the country out of 30 educational institutions (source - "A Data-Based Assessment of Research-Doctorate Programs in the United States" National Academies Press, DOI: 10.17226/12994). This is a periodic review performed by the NRC of graduate programs throughout the Unites States. The report was submitted to the K-State Graduate School and then later reported to the various departments/programs. Since spring 2015 the program has required GRE scores as part of the application for the PhD and MS degrees. GRE scores average about 310 (verbal + quantitative - 64% ranking) for on-campus MS and PhD applicants and 300 (45% ranking) for the MS distance applicants. When evaluating applicants for admission, the GPA requirements of the graduate school are enforced where a B or better GPA is required for the last two years of undergraduate studies. Acceptance rates are about 70% for both the PhD and on-campus MS degrees, while the MS online rate is 95%.

This is because applicants for the online program are pre-counseled as to requirements and advised not to apply if the probability of acceptance is low. The average total GPAs for the class of applicants from 2009-2016 were: PhD 3.5, MS campus 3.4 and MS distance 3.1. The graduation rate for all on-campus graduate food science degrees is close to 100%, while the online MS degree rate is 80%. The higher non-completion rate for the online students is often due to changes in employment and family situations. Since fall 2009, a total of 236 students have graduated with a Master's degree in Food Science, and 15 have graduated with the Ph.D. On average students collectively make about 15 presentations annually at national meetings on their research projects. Since the inception of the Food Science Graduate Program, Kansas State University students have been winning highly competitive internships and scholarships from IFT, Kellogg's, Phi Tau Sigma honor society, as well as internal scholarships such as the Timothy Donoghue Award and the KSU Research Foundation Graduate Award. Both MS and PhD students have been very competitive (placing 1st or 2nd) in annual competitions sponsored by the professional societies such as the Institute of Food Technologists (IFT), International Association for Food Protection (IAFP), American Association of Cereal Chemists (AACC), and American Meat Science Association Annual Reciprocal Meat Conference (RMC). They have been finalists and won several product development competitions sponsored by the Research Chefs Association, AACC, DuPont, IFT and the National Dairy Council. Several students have presented at the Capitol Graduate Research Summit held in Topeka.

External Demand. In 2015, then U.S. Secretary of Agriculture, Tom Vilsack reported that a recent study showed a greater number of jobs available in the ag-related industry than job-seeking college graduates; this market evaluation includes food science jobs as well. A food science degree prepares students for jobs in quality assurance, food safety program management, product/operations management, product development, technical sales and support, graduate school, regulatory and others. Our K-State food science students have virtually 100% placement upon graduation and often receive signing bonuses. The graduate program is unique because we offer traditional on-campus degrees and a distance education Master of Science degree. To our knowledge, no other program offers this. Most online students receive financial support from employers to further their education through our distance education program. Faculty from other universities have stated they will actually refer their students to Kansas State's online Food Science graduate courses because our courses offer both variety and exceptional quality. Companies that interview our students have told us that the Kansas State University Food Science degrees are well-respected throughout the United States and internationally. To enhance interaction with diverse stakeholders in the Kansas City metroplex, one full-time food science graduate faculty member is permanently stationed at the K-State-Olathe campus. This robust food safety and quality research component involves MS and PhD students in various graduate-level courses. In the last eight years, students graduating from our program with the MS degree have been employed at Bacardi, Target, Sargento Foods, Caravan Ingredients, Conagra Foods, Brown-Forman Group, Cargill, Continental Mills, Dairy Farmers of America, Dole Food Company, Food Safety Net Services, General Mills, Iowa Pork Producers, Kellogg's, Kerry Ingredients and Flavours, Mars, Pepperidge Farms, Perdue Farms, Post Consumer Brands, Hershey Foods, Nestle, US Department of Defense, Pepsico, ConAgra, Schwans, and Boar's Head Provision Company, to name a few. Within the last few years, our Ph.D. graduates have been hired by Mars, ConAgra, Cargill, Frito-Lay, General Mills, Kellogg's, and Tyson. PhD graduates have also been hired at the University of Idaho, Western Kentucky University, North Carolina A&M, Jordon University, University of Thailand, University of Turkey, and the University of Saudi Arabia. Graduates find employment in positions such as Senior Food Technologist/Scientist, Quality Assurance Manager, Product Development Manager/Scientist, Meat Processing Scientist, Consumer Scientist, Product Developer Sensory Scientist, Process Engineer, Quality Assurance Technician, Laboratory Manager, Extension Specialist, Food Safety Manager, HACCP Coordinator, and Operations Supervisor. Salaries in these positions are quite competitive and are similar to those published by the latest IFT salary survey (2015)

and provided by K-State's Career Center (online reports). Starting salaries for the MS degree are in the range of \$50-\$65,000; while the PhD degree holders start in the range of \$70-90,000. Our currently employed online students have average salaries of about \$75,000 and this is reported to increase once the MS degree is obtained.

Service Provided to the Discipline, the University and Beyond. Faculty teaching in the food science undergraduate program provide the core faculty in the Food Science Institute. In addition to the academic program, which develops human capital for the food industries, food science faculty provide cutting edge research, new technologies and highly valued extension/outreach to companies in Kansas and around the globe. Food science faculty and students have actively participated in undergraduate international programs, with at least one faculty-led trip to Italy, Spain or Germany, annually since 2008. Instructional service is used by all departments within the College of Agriculture and students in other colleges often take food science courses that relate to their interests. Currently, the impact of faculty in the Food Science Graduate Program extends beyond campus to the distance education community composed of working professionals in the food industry. The Food Science Graduate Program offers strong course work and research in food chemistry and analysis, food microbiology and safety, functional foods, food defense, sensory analysis, food engineering, and product development. The Value-Added Program in Food Science provides educational opportunities and technical assistance to food processing operations in product development, ingredients and packaging technologies, quality assurance, regulatory compliance, and food safety. The program offers help to medium and small sized food manufacturing plants, and handles hundreds of informational/guidance requests annually from processors and entrepreneurs, develops food product labels and analyzes products (chemical, physical, microbiological and/or sensory). The funding for this program is primarily from the Kansas Department of Agriculture, and it often receives federal grant funding.

*Cost Effectiveness.* The food science undergraduate degree program is credited with its own majors; however, student credit hours generated and costs are embedded in the Animal Sciences and Industry Department. In 2016, the ASI department generated ~2.7% of all K-State's undergraduate student credit hours while receiving an average of 2.2% of the K-State's General Use Expenditures. Given the high percentage of food science classes that have laboratories, the high costs of maintaining teaching laboratories, and that over 95% of the student credit hours are generated in courses taught by tenure-track faculty, the ASI and Food Science programs are best described as highly cost effective. Additional instructional FTEs are warranted if the department is to continue to enhance its scholarly activities and research productivity. The Food Science degree program exceeds the BOR standards for numbers of majors (237 students in 2016), degrees conferred (60 graduating seniors in 2016), faculty with terminal degrees (9), and average ACT composite score (undergraduate ACT average 25.4 in 2016).

As an interdisciplinary program, the Food Science Graduate Program is unique in that it does not have direct ownership of its faculty or of the research facilities its students use. The interdepartmental nature of the Food Science Graduate Program limits participation of some of its graduate faculty members because of other demands from their home departments. As discussed in section 2, a ten-member coordinating committee oversees the general operation of the program and includes members elected at-large. The graduate program is coordinated by a part-time chair elected by the Food Science graduate faculty and serves a three-year term with support provided in the form of partial release time from the home department and a nominal annual honorarium. A full-time program assistant in the Food Science Institute, funded by the dean of the College of Agriculture, provides part-time support for business related to the Food Science Graduate Program.

# Grain Science: Master's and Doctorate - CIP Code - 01.1002

*Mission, Centrality, Uniqueness.* Ever since its establishment more than 80 years ago, the Grain Science Graduate Program (GSGP) has aligned itself with the Grain Science Department's stated mission. The department's current mission is "To educate, innovate and transfer knowledge which significantly affects the cereal grain industry and to produce students who are well rounded, hardworking leaders who solve problems." The statement reflects the fact that the department, and by extension, its graduate program is unique among US degree granting institutions in its focus on the postharvest storage, processing, chemistry and food/feed uses of cereal grains. Its mission and the results of its educational and research activities are, therefore, central to and critical for the Kansas Ag economy as well as the US and world grain industry. To maintain this centrality, the GSGP interacts extensively with stakeholders (individuals and companies in the cereal processing, storage and food industries to make sure that our 'products', MS and PhD graduates, are well trained, not only in the scientific aspects of their discipline but also in the issues and challenges currently facing the entire food production chain worldwide. Its success in pursuing its mission is manifested in the desirability of its MS & PhD students (100% job offer rate) and their subsequent success in their careers.

*Quality of the Faculty.* The Department's 12 person graduate faculty have won 38 college, university or international awards since 2011. These include awards for excellence in teaching, research, advising and service. Two of the faculty are University Distinguished Professors and 6 hold endowed professorships. Our faculty have been particularly successful in obtaining extramural funding to underwrite their research and graduate students. Since 2011, the faculty have raised a yearly average of \$4,800,000 in research dollars, and published a yearly average of 52 peer reviewed research articles. Five of its faculty members serve on the senior or executive editorial boards of peer reviewed journals and one member serves as an Editor-in-Chief. GSGP faculty members have received numerous USDA/NIFA awards and was the lead department in the recent multi-institution PHL Feed the Future award. The combination of the GSGP's unique set of expertise and its close, positive relationship with the cereal processing and cereal foods industries has made the faculty particularly successful in obtaining research funding from those industries. The department's International Grains Program provides valuable outreach to the grain marketing and processing community. Faculty routinely organize and speak at technical short courses, international scientific conferences. They serve on the boards of directors, officers and key leaders of their scientific organizations (AACCI, IFT, ASABE, AFIA, PFA).

**Quality of Degree Program.** The GSGP offers both MS and PhD degrees thru traditional, on-site means. The program has had an averaged a total of 52 graduate students (MS plus PhD). Fifty-six percent of these have been doctoral students. Over the same time period, the male/female ratio has averaged 48% female. The MS student population has averaged 54% domestic and the PhD student population 36%. Required qualifications for admission are high as the department has deemed only ~26% of PhD applicants and 35% of MS applicants as being acceptable for entry into the program. The actual number admitted depends on the availability of funding and the student needs of the graduate faculty due to normal student flux thru programs. Over the past 5 years, department graduate students have received >150 national or international awards for teaching quality and research quality as well as external scholarships or fellowships. Award types include AACCI Best Student Research awards, IFT Student Product Development competitions, best student poster presentations and KSURF Graduate Awards. The GSGP graduation rate has been >90% of those admitted.

*Employer Demand.* Due to the uniqueness and quality of the training it provides, demand for the department's MS & PhD graduates is high, exceeding supply for well over a decade. Industrially, any processor of cereals, producer of cereal foods, feeds or ingredients would be a likely employer of our graduates. GSGP graduates have been hired by Cargill, Conagra, Nestle, General Mills, LeSafre, Corbion, Ingredion, Frito-Lay, Pepsico, Kelloggs The Schwan Food Company, Kerry Ingredients and many others. Masters level graduates typically take technical positions (cereal technologist, cereal scientist, product development scientist, quality lab staff/manager). Doctoral

graduates typically take more senior positions involving more basic research/technology as well as lead product development scientist. GSGP graduates command premium salaries with MS graduates averaging nearly \$70,000 and PhD graduates close to \$80,000. Although our doctoral students, typically do not pursue postdoctoral positions, the percent that who do has increased 10-15% in the past two years. A small proportion of doctoral grads (<10%) go on to academic positions, particularly international students returning to the institutions who have underwritten their graduate studies.

*Service Provided to the Discipline, the University and Beyond*. Many of the department's graduate courses, including GRSC 602, 625, 780, 745, 820, 825, 830, 901 and 915 are taken by graduate students from other programs including Food Science, Agronomy, and Biological and Agricultural Engineering. GSGP faculty serve routinely on the MS and PhD committees of a wide range of non-department students. Faculty have served as the international assessor/committee member of MS and PhD students in the UK, Kuwait, Denmark, Belgium and Spain. GSGP faculty members routinely respond to technical questions from individual citizens, both from Kansas and elsewhere, and serve as technical/science resources for County Agents with questions. Well over 50% of the program's faculty engage in consulting with private industry. Faculty also serve as expert witnesses, chair grant review panels, serve on journal editorial boards, write and/or edit scholarly books, present their research at scientific conferences and symposia, organize those same meetings, serve on supervisory committees for non-GRSC graduate students.

*Cost Effectiveness.* The investment in facilities, faculty and graduate student funding by the department, College of Agriculture, and University has, of necessity, been modest in recent years. Even so, the GSGP is a 'low overhead' research and training program. It has limited laboratory facilities and a relatively small graduate faculty (currently 9, temporarily down from 12). However, because six GSGP faculty positions are funded partially or entirely from endowed or non-university sources, the program still makes effective use of its available salary dollars. Likewise, the great majority of Graduate Assistantships in the department are funded extramurally, not by the department or College. Finally, the GSGP has a relatively large number of adjunct members. Many of these are senior research scientists in companies funding faculty/student research in the department. The GSGP leverages these individuals by having them serve on graduate student supervisory committees as well as present guest lectures in graduate classes.

# Agronomy: Bachelors, Master's, Doctorate – CIP Code – 01.1102

*Mission, Centrality, Uniqueness.* The Department of Agronomy, together with the Research and Extension Centers, provides statewide leadership for teaching, research, and extension activities in plant breeding, crop production, range science, soil science, and weed sciences. The Department contributes to activities in genetics, water science, climatology, precision agriculture, and environmental sciences. Agriculture is of preeminent importance to the economy of Kansas, accounting for roughly 40% of the state's total economy. Agronomy programs directly affect the productivity of 60,400 farms on 46 million acres of cropland and rangeland in the state. In accordance with the land-grant tradition of providing a scientific basis for agricultural and applied sciences, Agronomy has the unique responsibility of supplying the educational and research leadership in crops, range, soil, and weed sciences throughout the state. The Department has a responsibility to train international students and provide leadership in agronomy to developing countries and is the only department in Kansas institutions of higher education that offers B.S., M.S., and Ph.D. Agronomy degrees. At the regional and national level, K-State's Agronomy program is widely recognized as one of few that continues to emphasize applied education and research of direct benefit to the state's farmers and ranchers.

*Quality of the Faculty.* In the past five years, Agronomy faculty have received 15 national awards, two Higuchi awards, two Iman Awards, two KSU International Educator of the Year Awards, two Commerce Bank Distinguished Faculty Awards, one endowed faculty position, and two additional University Distinguished Professor designations. Five faculty members have or do hold positions as President of their professional organizations and four hold significant positions in national or international organizations, such as the Food and Agriculture Organization of the United Nations, the National Academy of Sciences, and the International Union of Soil Sciences. Evidence of effective teaching includes the receipt of 12 campus and national teaching awards by faculty in the past five years. Average new grant support has been \$6.7 M each year and Agronomy has been the top department in the College twice in the past five years (2nd or 3rd the remaining years) and the top department for all of KSU once. Significant gains have been made in enhancing the gender diversity of the department.

*Quality of Degree Programs:* The Agronomy undergraduate program includes a core of students with exceptionally high ACT scores. For example, in Fall 2016, 23 undergraduates had an ACT composite score of 28 or above. The academic and leadership qualities of these students carry over to the entire group of undergraduates. The Wheat State Agronomy Club is recognized nationally as one of the top undergraduate clubs. Since 2014, Agronomy students have held two national officer positions in SASES. In addition, Agronomy students were selected to receive the most prestigious awards given to undergraduates at the national/international level by ASA, CSSA, and SSSA. Enrollment in the Agronomy major has increased from 125 in F-10 to 192 in F-15. The enrollment in F-17 was 177. The options in the Agronomy major include Consulting and Production, Business and Industry, Plant Science and Biotechnology, Soil and Environmental Science, and Range Management. Added in Fall16 was a new Precision Agriculture option responding to requests from industry.

Enrollment in the M.S. program has remained stable during the past five years, but it increased significantly in the years immediately following the 2008 full-cycle review. The current 5-year average enrollment of 37 represents a 15% increase over the 5-year average enrollment of 32 in 2008. Enrollment in the Ph.D. program has more than doubled during the last eight years. The current 5-year average enrollment stands at 44, whereas the 5-year average enrollment in 2008 was 20. As part of its Strategic Action and Alignment Plan for K-State 2025, the Department has been working to raise the number of doctoral degrees awarded to a level comparable to those awarded by benchmark institutions. From 2008 through 2016, we admitted three students with Fulbright scholarships and two with BHEARD scholarships. Two additional students with Fulbright scholarships have been admitted for the Fall 2017 semester. From 2009 through 2016, 107 students were admitted to our M.S. degree program. Of those students, 64 have graduated, 31 remain in the program (predominantly recent entries), and 12 left the program. Thus, of those no longer in the program, 84% (64/76) graduated. For the same eight-year period, 77 students entered our Ph.D. program. Of those, 35 have graduated, 37 remain in the

program, and 5 left the program. Thus, of those no longer in the program, 88% (35/40) graduated. The quality of student research and teaching contributions is recognized through numerous awards and scholarships. In the past five years, graduate students have won eight research awards, nine teaching awards, and eight prestigious national scholarships. There is a strong tradition of excellence in awards received for paper/poster presentations at annuals meetings of professional societies, such as the American Society of Agronomy, the North Central Weed Science Society, and the Society for Range Management.

*External Demand.* The placement rate of our graduating undergraduate students is essentially a 100% since 2010 (262 graduates). Job placement includes: 57% industry related positions, 11% pursuing graduate studies, and 32% return to production agriculture. Based on senior exit surveys from F-16 and S-17, the average starting salary was \$49,500, with a high starting salary of \$60,000. An alumni survey of graduates with an Agronomy major from 2009-14 indicated that a majority of respondents (74%) were employed full-time in an agricultural field (93%). Most respondents (77%) worked in positions directly related to their undergraduate field of study, and were using their education in their current career (96%). The most frequently cited areas of employment included: sales (30%), farmer or rancher owner or partner (14%), and consulting (11%); 19% of respondents indicated they were enrolled in Graduate School. A large majority of respondents reported that the Department of Agronomy's programs and courses prepared them for their career (77%).

Students completing the M.S. degree in Agronomy are in high demand. Data obtained from Career and Employment Services (CES) for past five years indicate a 95% placement rate, with 75% employed in professional positions, 20% pursuing further education, and 5% seeking employment. Many of our graduates are employed by seed companies, crop consulting firms, farmer cooperatives, private research firms, and large agribusiness companies (e.g., Monsanto and DuPont Pioneer). Others find employment as research staff at K-State, as county agents with Cooperative Extension, or as community college instructors. They are also employed by the Natural Resources Conservation Service (NRCS) and a number of different state agencies. A number of our graduates enter the profession as self-employed crop consultants, or as farmers and ranchers. Data obtained from CES indicate that, over the past five years, 58% of our graduates remained in KS, 30% took positions in other states, and 12% found employment overseas.

Demand remains strong for students completing the Ph.D. degree in Agronomy. Data obtained from CES for past five years indicate 100% placement. Many of our Ph.D. graduates are employed as either faculty or postdoctoral researchers at universities in Kansas, the U.S., and overseas. Others find employment with private research firms, with many of the same large agribusiness companies that hire our M.S. graduates, or with federal agencies, like the US EPA and NRCS. Our graduates are also employed by a wide variety of other organizations, such as the Samuel Roberts Noble Foundation, the CSIR Savana Agricultural Research Institute (Ghana), and the Institute of Agricultural Economics and Rural Development (China), for example. Twenty percent of our Ph.D. graduates remained in KS, 53% took positions in other states, and 27% found employment overseas. Demand for individuals with advanced degrees in Agronomy is projected to remain strong in the foreseeable future. A 2015 report by Purdue University and the USDA indicates that employment opportunities in food, agriculture, renewable natural resources, and environment occupations are projected to grow more than 5% in the next five years.

*Service Provided to the Discipline, the University and Beyond.* Undergraduate and dual-level courses in Agronomy include the following K-State 8 tags: Empirical and Quantitative Reasoning, Natural and Physical Sciences, Global Issues and Perspectives, and Ethical Reasoning and Responsibility. An Agronomy minor is available to all students at Kansas State University. The enrollment in the Agronomy minor has increased from 20 students in F-10 to 60 in F-17. While completing their degree requirements, students in our M.S. and Ph.D. programs contribute to the missions of the Department, College, and University by serving as Teaching Assistants and assistant coaches for our five judging teams. In some capacity, all degree candidates contribute to our extension and outreach activities by presenting research findings at field days, extension meetings, industry-sponsored events, and professional society conferences and meetings. A number of

candidates also contribute to Department service programs, such as the Soil Testing Laboratory and the Crop Testing and Evaluation Program. In addition, a number of Agronomy faculty contribute to the Grassland Management Graduate Certificate Program and the Genetics graduate program.

Cost Effectiveness. Many of the resources required to teach these courses (laboratories, specialized equipment, field facilities, etc.) are supported via extramural grants and funding from the Agricultural Experiment Station. As a result, the department is able to offer 21 undergraduate courses, with 19 of those being traditional courses (i.e., not topics, problems, or research courses), and 25 dual-level courses that also serve our graduate program. Graduate education in our M.S. and Ph.D. degree programs is supported to a large extent by extramural grants awarded to members of the faculty. A relatively small fraction of the grant support is intramural (Kansas State University and State of Kansas). Of the approximately 64 M.S. and Ph.D. candidates per year on GRA appointments, about 82% receive their salary support from extramural grants other external sources of support (scholarships, fellowships, etc.). In terms of the physical resources and faculty time required to teach our graduate-level courses, considerable efficiency is achieved by the fact that our teaching and research programs are highly integrated. Many of the resources required to teach these courses (laboratories, specialized equipment, field facilities, etc.) are supported via extramural grants and funding from the Agricultural Experiment Station. The Department currently has 8.3 instructional FTEs, but those are distributed among 25 faculty involved in teaching. As a result, the department is able to offer 59 graduate-level courses, with 48 of those being traditional courses (i.e., not topics, problems, or research courses). Of those 48 courses, 25 are dual level and also serve our undergraduate program.

# Entomology: Master's and Doctorate - CIP Code - 26.0702

*Mission, Centrality, Uniqueness.* The Department of Entomology at Kansas State University has a tripartite mission of research, teaching, and extension, and these missions often overlap. Our mission is to: (1) provide entomological knowledge for a safe, sustainable, and competitive food, feed, and fiber system through integrated research and education; (2) maintain a stakeholder/clientele driven focus to research, extension, and teaching activities; (3) generate fundamental information for the advancement of science and for applied uses; (4) train students for professions in education, government, business and industry; and (5) disseminate useful, unbiased information. Entomology addresses a wide range of areas, including human and animal health, environmental awareness and conservation, sustainable protection of food and fiber crops, and fundamental understanding of biological systems. Our department is the only department of Entomology in Kansas, and has the broadest expertise in this field of any institution in the state. Kansas State University's Entomology department is one of 28 standalone departments of Entomology of the 42 across the nation.

*Quality of Faculty.* The department currently has 16 full-time faculty members who all hold the terminal degrees of Ph.D. and 15 of whom are tenured or tenure-track. All faculty are members of the Graduate Faculty with certification to direct PhD students. Faculty positions in Entomology are budgeted by the state according to assignments in Research (Kansas Agricultural Experiment Station), including approximately 11 FTEs for Research, 2.1 FTEs for Teaching, and about 2 FTEs for Extension. Three of our faculty are Fellows of the American Association for the Advancement of Science, and two are Fellows of the Entomological Society of America. One of our faculty is a University Distinguished Professor, and another holds a named professorship. The department is strengthened by collaborations with 24 ancillary (within KSU) and adjunct (outside KSU) faculty members from departments across campus, and the nearby USDA Center for Grain and Animal Health Research (CGAHR), as well as other institutions within and outside Kansas. Our faculty have garnered a variety of awards for teaching, research, and extension (http://entomology.k-state.edu/department-news.html) programming, underscoring their success in the Land-Grant University's tripartite mission. They averaged \$2.1 million in extramural research funds (\$190K per research FTE per year) and 72 refereed research publications (6.5 per research FTE per year) annually. The department was recently ranked as the number 4 department of Entomology in the world based on the number and quality of research publications by department personnel including faculty and students (http://www.cwur.org/2017/subjects.php#Entomology).

*Ouality of the Degree Program.* The department offers MS and PhD degrees in Entomology, and a Graduate Certificate. All courses are taught or co-taught by tenured or tenure-track faculty. Student acceptance is contingent on acceptance by a mentor and availability of funding to support the student as a graduate research assistant for the duration of the student's program. The program averaged 10 MS students enrolled annually in degree programs from FY2008-2016, with an 8-year average of 3.4 MS students graduating each year. The number of MS students has declined somewhat from an average of 11 MS students annually from 2008-12 to 9 annually from 2013-16, although this decline has been more than offset by an increase in PhD students, which aligns with the K-State Vision 2025 plan. The program averaged 18.5 PhD students enrolled annually in degree programs from FY2008-2016, with an 8-year average of 3.5 PhD students graduating each year, with the number of PhD students rising from an average of 17 students annually from 2008-12 to 21 annually from 2013-16. The PhD program is currently ranked 8th nationally by the National Research Council for quality among the 42 departments with strong entomology cores. This ranking and our quality are reflected in the numerous institutional, regional, and national awards received by our students and faculty (http://entomology.kstate.edu/department-news.html). We are aware that the number of MS graduates in our graduate program fell below the Board of Regents five-year average (FY 2012-2016) of 20 students and 5 graduating per year (with 10.4 and 3.8 per year in our program, respectively). In contrast, our PhD program averaged 21.8 students in the program and 3.4 graduating each year during the evaluated period, significantly exceeding the Board of Regents five-year average of 5 majors and 2 degrees conferred. Our MS program provides an important entry point for our PhD programs, and thereby has contributed significantly to the nationally recognized strength of our PhD

program. Continuation of the MS program in our department is deemed vital to the continued success of our PhD program.

*External Demand.* Our graduated MS students for whom we have accurate records (from 2008-16) have had a 91% placement rate in positions or continuing in graduate school (total tracked = 25). Graduates have taken positions in research support (New Jersey -1); military (2); private industry (Arkansas -1; Kansas -1; Iowa -1; Oregon -1: Brazil -1: Uruguay -1): federal positions (Washington DC - 1): teaching positions (Indiana - 1): nonprofit positions (Africa -1; India -1); and gone on to graduate school (10 – Kansas, Tennessee, Florida, Arkansas, Texas). Two others were actively seeking positions at the time they were contacted. Our graduating PhD students from 2008-16 have had a 100% placement rate in positions (total tracked = 25). Graduates have taken academic faculty positions (Oklahoma -1; Brazil - 2; Colombia - 1; South Korea - 1; Thailand - 1); postdoctoral research positions (KSU/Manhattan USDA -11, South Carolina – 1, USDA, Maryland – 1; California -1; Florida – 1; Nebraska -1; Ohio -1; Switzerland -1); and a federal position (Maryland -1). Employment opportunities continue to be very good in a wide range of sectors (academic, government, private industry, medical, etc.), and our department has a strong track record of placing graduates. A growing human population in need of protected food, problems with invasive pest species (e.g., sugarcane aphid, emerald ash borer, brown marmorated stink bug), and invasive pathogens transported by insects (e.g., Zika virus, West Nile virus, Dengue, Citrus greening disease) will continue to maintain a need for well-trained entomologists to anticipate and respond to problems. Further, insects are critical model organisms for the study of genetics, aging, medicine, and ecosystem health. The program is developing new learning about the pharmacopeia that insects may offer to address causes human suffering, such as cancer and arthritis. The value in studying insects is only going to increase in years ahead.

*Service provided to the discipline, the University and beyond.* Six undergraduate courses support majors in other departments and diverse colleges. The program hosts more than 25 undergraduate students in labs each semester for engagement in research. The graduate courses also support other departments (e.g., courses in professional development ENTOM800, insects of stored products ENTOM805, and biological control ENTOM820 typically have enrollees from other departments that make up a significant portion of the class). The program is actively engaged in teaching, research, and extension/outreach. Teaching and research have been noted above, but we also have a strong extension and outreach presence. The faculty are actively engaged with the agricultural community and county extension across the state to transfer critical information to them. The graduate students engage in monthly outreach programs and events to support our communities with insect-related public education. The K-State Insect Zoo hosts over 8,000 visitors annually, and is a valuable resource for local and extended outreach. It is also an excellent facility to train our students to better connect with the public in science education.

*Cost Effectiveness.* The 2.1 teaching FTEs in the department cost \$233,949 annually in salary, or \$111,404 per FTE. We averaged 28.5 graduate students (MS and PhD) per year enrolled in the department, each costing an average of \$23,200 per year to support in an assistantship, for a total of approximately \$661,200 annually in assistantship costs. The department budget includes \$138,000 for graduate research assistantships and \$18,000 for graduate teaching assistantships, meaning that the faculty are supplementing approximately \$505,000 annually from extramural funds to support our graduate student population – more than double the salary allocated to the department for teaching. Moreover, the \$2.1 million annually in faculty extramural research funding supports the graduate research programs and professional development (e.g., professional meeting participation) of the students, as well as improving facilities and infrastructure at a time when university funding is unable to do so. Student contact hours has increased over the past 8 years: departmental instruction generated an average of 1253 student contact hours per academic year during FY2013-2016 (502 SCH in graduate courses), compared with 1036 per year from 2008-12 (428 SCH in graduate courses).

# Genetics: Master's and Doctorate - CIP Code - 26.0801

*Mission, Centrality, Uniqueness.* Our mission is to educate students with a broad knowledge of genetics, the study of the inheritance and function of genes that control all life on earth, and with an in-depth ability to perform genetic research in an area of specialization such as plant or animal breeding, or such as genetic and genomic analyses of plants and plant pathogenic microbes, nematodes and insects to produce pest-and drought-resistant crops and increase crop yields. Within the Regents System, the KSU Genetics Program is unique in training geneticists in agricultural sciences. Therefore, this program offers critical educational opportunities for Kansas, the state that ranks 2nd in total U.S. cropland and 1st in production of wheat and sorghum. The Genetics Program contributes strength in population and evolutionary genetics, quantitative genetics, molecular and developmental genetics, and bioinformatics. Interdisciplinary interactions often bridge basic and applied genetics and merge diverse fields such as agriculture and computer sciences. The program offers students opportunity for in depth knowledge across genetics specialities through courses in multiple departments, as well as specialization in a genetics sub discipline. The Genetics Program also offers a Graduate Certificate in Genetics, Genomics, and Biotechnology (CGGBT) to serve individuals wishing to work in the biotech industry. The CGGBT provides students in diverse disciplines with knowledge of biotechnology and genetics/genomics, and is aimed at traditional graduate students on the Manhattan and Olathe campuses, as well the regional biotech work force.

*Quality of the Faculty.* The Genetics Faculty currently includes 43 members from the Division of Biology and the Departments of Agronomy, Animal Sciences and Industry, Biochemistry and Molecular Biophysics, Entomology, Horticulture and Natural Resources, Plant Pathology and Statistics. Faculty members are internationally-recognized researchers and teachers who receive over \$8.5 million in annual external research funding. Six faculty are University Distinguished Professors; 11 have been elected Fellows of AAAS and/or discipline-specific societies (19 total); 2 have received significant Early Career Awards. Faculty members have been recognized for excellence in teaching or mentoring, including 2 University Distinguished Faculty Awards for Mentoring of Undergraduate Students in Research, 2 College of Agriculture Excellence in Graduate Teaching Awards, the Joan S. Hunt Distinguished Mentoring Award (K-INBRE) and an Outstanding Graduate Faculty Award from Biology graduate students. One member has received 6 teaching awards since 2012, including North American Colleges and Teachers of Agriculture Teacher Fellow, and the American Society of Animal Science Midwest Outstanding Young Teacher. Many students apply to the program based on interest in working with a specific faculty member.

*Quality of Degree Programs.* The Genetics Program recruits students and trains them as geneticists who are highly competitive for academic, governmental and industrial jobs within our state, region and nation. Five Ph.D. students from the review period have been funded by the internationally competitive Monsanto Beachell Borlaug International Scholarship Program. Our program quality is demonstrated by our students' successes in academic scholarship during their graduate studies and their excellent employment record after graduation. M.S. students typically graduate with at least one research publication, and Ph.D. students graduate with 2 to 5 publications. Our students win numerous awards competing at the university, national and international levels, including the prestigious Award for Scientific Excellence in a Feed the Future Innovation Lab from the Board for International Food and Agricultural Development. Our students present numerous invited talks and posters at national and international meetings. The Genetics Program offers students an interdisciplinary and interactive environment with access to state-of-the-art facilities and centers, including the Integrated Genomics Facility, the Bioinformatics Center, the Wheat Genetics Resource Center, the Center for Sorghum Improvement, the Fungal Genetics Stock Center, the Arthropod Genomics Center, and the Ecological Genomics Institute. The degree program quality depends on offering both M.S. and Ph.D degrees. The 5-year M.S. enrollment (8 [annual average of 1.6]) and degrees (1 [annual average of .2]) is characteristic of the genetics field due to the broader range of career opportunities for Ph.D. graduates. The five-year Ph.D. enrollment (81 [annual average of 16.2]) and degrees conferred (8 [annual average of 1.6]) balance the threshold expectations. Since the Spring 2016 enrollment period, only 28% of applicants to the Genetics Program applied for an M.S. degree. Based on available

funds, 30% of M.S. applicants were accepted, compared to 50% of Ph.D. applicants. However, the Genetics M.S. degree is the correct option for career choices such as certain industry or government research scientist positions. The M.S. option increases our ability to attract Ph.D. students, because some students do not immediately qualify for the Ph.D. program. Obtaining an M.S. degree at KSU provides these students with sufficient preparation. Retaining the M.S. program is possible at no extra cost and it is critical for the strength and competitiveness of our Genetics Program.

*External Demand.* In surveys commissioned at the K-State Olathe campus in 2010, leaders of many animal-and plant-focused businesses in the greater Kansas City area expressed need for a large pool of well-trained job candidates with expertise in modern genetics, genomics and biotechnology. The 100% employment record for Genetics graduates from this review period illustrates external demand. Three Ph.D. graduates are now wheat breeders (at Syngenta, Junction City, KS; Long Reach Plant Breeders, Australia; and Michigan State University, MI). Three Ph.D. graduates are industry or academic researchers (Dupont-Pioneer, Zoetis, Harvard); one has an international agricultural research position in Senegal; and one is an Assistant Professor in India. Our M.S. graduates are research scientists in industry (Advanta Seed, Manhattan) and academia (Cornell U.). Recent Ph.D. graduates are post-doctoral researchers in the U.S. and Europe.

Service Provided to the Discipline, the University, and Beyond. The Genetics Program is small but high-impact. Genetics faculty and their students are breeding improved varieties of wheat, sorghum and soybeans for Kansas farmers. Others are developing genomic tools to speed delivery of new crop varieties to farmers world-wide. Faculty and students are cloning valuable crop resistance genes and producing genome-editing strategies to control pests. Others are discovering essential biology of pathogens and insects for designing novel control strategies. One faculty member provides genomic services to the entire university through leadership of the Integrated Genomics Facility. Others distribute wheat germplasm and fungal genetics stocks world-wide from the Wheat Genetics Resource Center and the Fungal Genetics Stock Center, respectively. Genetics faculty play major roles in 3 of the USAID Feed the Future Innovation Laboratories led by KSU, including leadership and research roles for the "Applied Wheat Genomics" and "Reduction of Post-Harvest Loss" labs, and research roles in the "Collaborative Research on Sorghum and Millet" lab. Faculty have national and international consulting roles, such as serving on Scientific Advisory Boards for the French BreedWheat Project and the German Max Planck Institute for Terrestrial Microbiology. International conferences organized include the annual Fusarium Laboratory Workshop, the International Triticeae Mapping Initiative, and the International Workshop on Wheat Blast in Brazil. Genetics graduates are assuming jobs in universities and colleges, in hospitals, in agricultural, pharmaceutical and biotechnology industries, and in government agencies. Genetics is at the heart of the revolutions of biotechnology and genomics that have major impacts on the lives of individuals in our society.

*Cost Effectiveness.* All courses required for the Genetics curriculum are already taught for students in the Division of Biology and participating departments, and these courses would continue to be taught even without a Genetics Program. The existence of these courses illustrates the centrality of genetics to all disciplines in biological sciences. The Genetics Program allows students to acquire in depth genetic knowledge across disciplines through courses in multiple departments. No additional faculty time is required for Genetics majors, and no special infrastructure or equipment are required. Importantly, the Genetics M.S. program does not require extra resources relative to the Ph.D. program. Administrative chores do not change depending on the degree obtained. In 2013, in recognition of the importance of the Genetics Doctoral Fellowship Program, which provides 3.5 years of funding for two new Genetics students per year. This lab-independent funding enables us to be competitive in recruiting high quality, diverse graduate students. As is typical in the best U.S. research universities, Genetics Fellows experience working in 3 genetics laboratories before choosing one. Lab rotations strengthen the breadth of experience for the students and increases the research output for multiple faculty and the program overall.

# Pathobiology: Doctorate - CIP Code - 26.0910

*Mission, Centrality, Uniqueness.* The Pathobiology Graduate Program is an interdepartmental and interdisciplinary program with a mission to provide a broad-based graduate education to students seeking a PhD degree in the field of Veterinary Medicine, specifically in Microbiology, Pathology, Immunology, Toxicology, Epidemiology, Cancer Biology, and Production Animal Medicine and Management. The faculty in the graduate program have established programmatic requirements for admission, supervision, and completion of the degree, within the overall policies of the graduate school and provide both the course-based education and the research training essential to accomplish the mission. The uniqueness of the Graduate Program is that it is the only program in the State of Kansas that offers a Ph. D degree in Veterinary Pathobiology, a field of Veterinary and Comparative Medicine that includes disciplines to study infectious and non-infectious diseases of animals and humans, food safety and security, and production animal medicine and management. Additionally, the Pathobiology Graduate Program encourages and offers opportunities for DVM students to concurrently work on a dual degree program (DVM/PhD) to gain research experience, which will prepare them for careers in academia or health and allied industries.

*Quality of the Faculty*. Currently, the program has 79 faculty members primarily from the Departments of Diagnostic Medicine/Pathobiology (DMP; 51) and Clinical Sciences (5) in the College of Veterinary Medicine. The faculty in the Pathobiology Graduate Program have a national and international reputations in areas of transboundary diseases, swine viral diseases, vector-borne diseases, and food safety and security. Seven faculty in the program have the title of University Distinguished Professor, the highest honor accorded by the university, which includes one with the title of Regents Distinguished Professor. Four faculty in the program have received Dr. Ron and Rae Iman outstanding faculty award for research (2) and teaching (2) in the university. A few national awards received by the faculty include Distinguished Microbiologist of the year, National Pork Board Innovation in Research, 2016 Science to Art, best manuscript published in a journal, etc. Two yardsticks to highlight the quality of the faculty are success in obtaining grants and publications of books, book chapters, and manuscripts in peer-reviewed journals. Researchers in the program have been highly successful in generating extramural funding to finance research and graduate education. The DMP has been ranked consistently in the university as the top or next to the top in the total research funding for the past several years. Just in the academic year of 2016, faculty in the program have authored a text book, 13 book chapters, and 333 journal papers.

*Quality of Degree Programs.* A number of graduate students in the program have a DVM degree or in a dual DVM/PhD program. Currently, the program has 42 students and of those 18 are post-DVM and 9 students are pursuing a concurrent DVM program. In the last seven years, 63 students were admitted to the PhD program and of those three students switched to the MS program, one transferred to a different university, and one student dropped out of the program. Since the academic year of 2012, there has been a steady increase in the number of students admitted to the program (28 in 2011-2012 to 41 in 2016-2017). Of all the sub-specialties in the program, Virology has the highest number of students, reflective of the emergence of a number of viral diseases in animals and some of them are potentially zoonotic. Our students have consistently received recognitions for best research oral or poster presentations in national meetings. Each year, in the first week of March, a Research Day is organized to show case graduate students research accomplishments in the College of Veterinary Medicine. Since 2009, a total of 52 students have graduated with a doctoral degree and collectively they have published 231 peer-reviewed publications, which averages to 4.4 publications per doctoral dissertation.

*External Demand.* All of the graduates, except one, have secured almost immediate employment. A large majority of the graduates have positions that involve teaching and or research in the area of animal health and welfare. Some of the graduates (11) have opted to have post-doctoral training to further enhance their research skills. The primary employers of our graduates are academic institutions (19; University of Pittsburgh, Kansas State University, North Carolina State University, Texas A&M University, Washington State University, two universities in China) or animal health and allied industries (15; Bayer Animal Health in Kansas, Elanco Animal

Health in Indiana, Merck Animal Health in Kansas, Veterinary Biomedical Research Center in Kansas, Feedlot Health Management Services in Canada). The other employers include state or federal agencies (3; Kansas, Kentucky, New Mexico, Michigan) and private consulting business or practice (3; Kansas, Colorado).

*Service Provided to the Discipline, the University and Beyond*. The faculty in the Program/Department teach a number of courses for the DVM students and graduate courses to graduate students in the Pathobiology program and from other graduate programs in the university. A number of courses offered by graduate faculty in the program are taken by graduate students in other colleges/departments. Many of the courses are highly specialized and taught by faculty with extensive research experiences. In the past two years, faculty in the program have initiated two unique courses, Essential Practices for Bio Safety Level-3 Research Settings and Introduction to High Containment Research Topics and Techniques, which make use of the Biosecurity Level-3 Research Facility (Biosecurity Research Institute). Such courses coupled with laboratory experiences in BSL-3 laboratories will prepare the students to work in a research facility like National Bio and Agro Defense Laboratory. The institute and centers (Beef Cattle Institute, Center of Excellence for Emerging and Zoonotic Animal Diseases, Center of Excellence for Vector-Borne Diseases, and Center for Outcomes Research and Education) housed in the department also offer opportunities to a number of faculty and graduate students in other departments in the university to participate in collaborative research.

*Cost Effectiveness.* The Pathobiology Graduate Program is managed by a faculty member (Director of the Pathobiology Graduate Program) with a 5% of the faculty time committed to administer the program. The pathobiology graduate program is extremely cost effective because the graduate research assistantships and student's research expenses are entirely supported by research funds generated by the faculty. Graduate student salaries in the Pathobiology Graduate Program range from \$21,000 to \$40,000, with a median salary of \$25,000. The tuition fee of most graduate students are not paid by the program, however, a few student's tuition fees are paid out of major professor's grants. Additionally, a total \$25,000 per year is made available by the Associate Dean for Research to support graduate student travel to scientific meetings.

# Applied Science and Technology: Professional Science Master's – CIP Code – 30.0000

This program will be reviewed in a future year as it is a recently implemented program.

# Biomedical Science: Master's, Doctorate - CIP Code - 51.2501

*Mission Centrality and Uniqueness.* The mission of the Veterinary Biomedical Sciences (VBS) Graduate Program is to prepare graduate students for a career in research and service in academia, animal health industry, public health, governmental agencies, and specialty veterinary practices or to pursue a doctoral degree in biomedical sciences. The program has three sub disciplines, Physiological Sciences, Clinical Sciences and Pathobiology, representing the three departments, Anatomy and Physiology, Clinical Sciences, and Diagnostic Medicine and Pathobiology, respectively, in the college. Students in the MS program have the option to pursue a thesis-based, report-based, or course work-based degree. A uniqueness of the program is that it is the only graduate program in the State of Kansas that offers a MS degree in disciplines of veterinary medicine related to animal health and well-being and public health. The program encourages and offers opportunities to DVM students to concurrently work on a dual degree program (DVM/MS) to gain research experience, which broadens their career opportunities. The MS degree is also beneficial to DVM students planning to get into a residency program with an intent to get board certified in a specialized field of veterinary medicine, such as ophthalmology, Cardiology, Radiology, Surgery, Internal Medicine, etc. Additionally, the program offers employees in academic departments in the university or in animal health industries to opt for a report- or course work-based degree to enhance their knowledge skills and to advance their career opportunities.

*Quality of the Program.* Overall, 199 students were admitted into the graduate program between 2009 to 2016. Students entered the program with a variety of previously earned degrees, including many with a DVM, a few with a MS degree in another field, and 48 students were in a dual degree program pursuing MS and DVM concurrently. Of the students with a DVM degree, 38 were in a concurrent residency program that generally culminated in board certification in specialized areas of Veterinary Medicine. During the reporting period, 105 students have graduated. Fifteen graduate students based on the recommendation of the major professor and often by the supervisory committee were recommended to skip the MS degree to pursue a PhD degree. A majority of the students that earned MS degrees were thesis-based (93%) and the rest were report- (5%) or course work-based (2%) degrees. Several graduate students have received recognitions for best research oral or poster presentations in national meetings (e.g., American Association of Bovine Practitioners, Academy of Veterinary Laboratory Diagnosticians, International Association for Food Protection, and Federation of American Societies for Experimental Biology). In addition to graduate student assistantships, in the past 5 years a total of \$55,350 has been awarded as scholarships to 55 students and approximately \$25,000 per year are awarded to support students to travel (approx. \$1,000 per student) to national scientific meetings.

Quality of the Faculty. Currently, the VBS Program has 118 graduate faculty members spanning three departments with research, scholarly and creative activities in specialized areas of infectious diseases, including transboundary diseases, zoonotic diseases, comparative biomedical sciences, cancer biology, nanotechnology, food safety and security, stem cell biology, and companion and food animal health. The program is served by a number of graduate faculty that have national and international recognitions, including a member of National Academy of Sciences Institute of Medicine, a Regents Professor, and 10 with the title of University Distinguished Professor, the highest honor accorded to the faculty in the university. Five faculty in the program have received Dr. Ron and Rae Iman outstanding faculty award for research (3) and teaching (2) in the university. Graduate faculty in the departments of Anatomy and Physiology and Diagnostic Medicine and Pathobiology have been very successful in attracting extramural grants from federal agencies, such as National Institute of Health, National Science Foundation, and the US Department of Agriculture. In fiscal years 2012 to 2016, the faculty in the Department of Diagnostic Medicine and Pathobiology have been awarded extramural grants that averaged \$9.2 million per year. Extramural awards to faculty in the Department of Anatomy and Physiology have exceeded \$3.3 million annually. The faculty are responsible for teaching a number of graduate courses, and in the past 5 years, several new courses, including courses on writing and communication skills, pathogenesis of infection diseases, research ethics, high containment and select agents' research, etc. have been developed.

*Employer Demand.* Students who have completed the Master of Veterinary Biomedical Science Program typically enter doctoral programs or pursue careers in academia, industry, and private or specialty veterinary practices. During this reporting period, 25% of our graduates have gone on to pursue a PhD, 28% are working in academia in a variety of positions from laboratory technician/research associates to instructors or Assistant Professor (Kansas State University, University of Maryland, Midwestern University, Mississippi State University, University of Queensland, Australia, Wichita State University; University of Helsinki, Finland, Washington State University, University of Tennessee, etc.), 15% are working in animal health industry related careers (Merck Animal Health, Desoto, KS; SeLux Co., Boston, MA, Bayer Animal Health, Kansas City) and 32% work in a private/specialty veterinary practice or clinics (Surgeon in Texas Equine Hospital in Bryan, TX, Surgeon at Common Equine Clinic in Suffolk, VA; Internal Medicine Veterinary practice are those that worked in the residency program and became board certified. The strong employer demand is because of the uniqueness of the graduate program. The breadth of disciplines in the program assures a wide career options to the graduates in Veterinary Biomedical Sciences.

*Service Provided to the Discipline, the University and Beyond.* The uniqueness of the program and the three sub disciplines within the program provide valuable service to other departments in the university, public health and other governmental agencies, animal health industries departments and to the health and welfare of pet, exotic and companion animals, and to the livestock industry, particularly swine and beef cattle industries. The faculty in the Program/Department teach a number of courses for the DVM students and graduate courses to graduate students in the Pathobiology program and from other graduate programs in the university. A number of courses offered by graduate faculty in the program are taken by graduate students in other colleges/departments, such as Anatomy and Physiology, Animal Sciences, Biochemistry, Biology, Food Science, and Grain Science. Many of these courses are highly specialized and taught by faculty with extensive research experiences, and are applicable to graduate students in other programs. The services offered through the various centers of excellence and institutes in the college offer opportunities to a number of faculty and graduate students in other departments in the university to participate in collaborative research.

*Cost Effectiveness.* In the past 8 years, the program has maintained an average of 60 graduate students each year and an average of 14 students have graduated each year. A steady increase in the average number of graduate students in the program for the past five years is indicative of the high demand for the Veterinary Biomedical Sciences Program and the wide career opportunities the program offers. The cost of providing the Veterinary Biomedical Sciences program relative to the benefits of the program is extremely low because the graduate research assistantships and student's research expenses are entirely supported by research funds generated by the faculty. The infrastructure and material support that are used to train students are not dependent on student enrollment; rather, it is required for faculty members to meet the obligations of their funding agencies.

# Physiology: Doctorate - CIP Code - 51.2503

*Mission, Centrality, Uniqueness.* Anatomy and physiology are core disciplines fundamental to the science and art of medicine. The mission of the Department of Anatomy and Physiology encompasses instruction, research and continuing education, endeavors that form the critical foundations of medicine. The Department plays central roles in the:

- education of veterinarians for Kansas, the nation, and the world;
- education and training of graduate students for biomedical careers in teaching, research, and industry;
- fulfillment of the University's mission to conduct basic and applied research important for the diagnosis and control of animal and human disease.

Modern medicine depends on continual acquisition of new scientific knowledge to advance understanding of animal and human health and disease. Doctoral students trained in the Veterinary Physiology Graduate Program (The Program) are key to the success of health professionals in the College, University, State, and Nation. Discoveries advanced by the disciplines of Anatomy and Physiology are unique in affording integration of new information, from molecular to organismal levels.

**Ouality of the Faculty.** The Program comprises 34 tenured, tenure-track, and research-track faculty members having primary appointments in 2 units within the College of Veterinary Medicine (CVM): 25 in Anatomy and Physiology, and 3 in Clinical Sciences. Additional members are from the College of Human Ecology (4 in Kinesiology; 1 in Human Nutrition), and the College of Arts and Sciences (1 in the Division of Biology; 1 in Biochemistry and Molecular Biology). The tenured faculty includes 5 University Distinguished Professors. Of this group, 2 carry additional special distinctions: 1 is Regents Distinguished Professor, while the other is the MacDonald Endowed Chair in Veterinary Medicine, Kansas Bioscience Eminent Scholar, and a member of the Institute of General Medical Sciences, National Academies. Between 2008 and 2016, extramural awards to faculty in the Department of Anatomy and Physiology alone exceeded \$3.3 million, reflecting a return of ~ 61% of amounts proposed and ~39% success rate on proposals submitted (19/49). Extramural funding agencies include the National Institutes of Health (NIH), the US Department of Agriculture (USDA), and the National Science Foundation (NSF). The faculty is responsible for delivering high-quality didactic instruction as well as teaching of practical methodologies and approaches necessary for success in cutting-edge, discovery research. Among the ranks are recipients of university and national teaching accolades (e.g. Kansas State Provost's Academic Excellence Award, Merial Teaching Excellence Award, Arthur C. Guyton Physiology Educator of the Year Award from the American Physiological Society). Faculty also distinguish themselves through delivery of invited lectures at Gordon Conferences and at international symposia (e.g., 29th Congress of the Bárány Society; Seoul, South Korea), peer-review for scholarly journals and extramural granting agencies, editorial service on major national and international journals (e.g., Journal of Physiology, Journal of Applied Physiology, European Journal of Applied Physiology, American Journal of Physiology), and local outreach activities.

*Quality of Degree Programs.* The Program is administered by the Department of Anatomy and Physiology and requires a research-based dissertation toward the Ph.D. degree, drawing upon the expertise and mentoring of its Graduate Faculty affiliates. The Program's Areas of Research Expertise comprise: 1) Cell Signaling, 2) Cell, Tissue, and Organ Development, 3) Integrative and Systems Physiology/Pathophysiology, 4) Nanomedicine, 5) Neuroscience, and 6) Pharmacology. The Program attracts local, national, and international students desiring training in emergent physiological questions pertinent to animal and human medicine. Strong emphasis is placed on research, carrying the expectation that original work be published in peer-reviewed, impactful journals. Thus, capacity for original thought and effective communication skills are cultivated to prepare Graduates from The Program to distinguish themselves as researchers and educators. Between 2008 and 2016, The Program admitted 25 of 100 applicants (76 international, 17 domestic, and 7 of unspecified nationality). Of those admitted, 13 (52%) completed The Program and 2 currently are enrolled. The mean GPA of this cohort was 3.73. Graduates of The Program garnered numerous intramural and national awards from prestigious scientific societies. Intramural awards include, in the CVM, the Marguerite L. Richards Graduate Student Scholarship, Dr. Charles E Cornelius

Graduate Student Travel Award, and the Dr G. Roger and Irene J. Spencer Award, as well as the University Distinguished Professors Graduate Students Award. National awards include pre-doctoral Recognitions Awards from the American Physiological Society, and an award in science advocacy from the American Association for the Advancement of Science. Ten (10) admitted students chose to realize goals more closely aligning with their academic aspirations, and transferred to other programs: 4 to the College-wide M.S. Program in Veterinary Biomedical Sciences, 3 to the Ph.D. Program in Veterinary Diagnostic Medicine, 2 to other programs at KSU, and 1 to a Ph.D. program at KUMC.

*External Demand.* Graduates of The Program are considered well-trained and are in demand. Roughly 69% (9/13) of The Program's Ph.D. graduates secured professional employment by the time of graduation. Of these, 6 placed readily as post-doctoral fellows at major national and international universities (U. Rochester, U. Colorado Denver, U. Texas El Paso, U. Utah, Penn State, Federal U. of Sao Paulo). During the reporting period, 4 of The Program's graduates secured tenure-track assistant professorships within 3 years post-graduation (KSU College of Human Ecology, Texas A&M, U. Oklahoma Stillwater, Nantong U.). Additional, non-academic career paths chosen by graduates include industry/biotechnology (e.g., Sera, Inc.; Lulike Animal Health), as well as scientific communications and advocacy (e.g., Crimson Interactive, an English language editing service).

*Service Provided to the Discipline, the University and Beyond.* Faculty in AP provide instruction to pre-clinical veterinarians, a goal demanding current relevancy of information delivered and fluency in contemporary research developments. In addition to contributing through original research to scientific advancement in their fields, there is a strong interdisciplinary component to the service of AP faculty and members of The Program. State-of-the-art Core facilities maintained by the department furnish a nexus for discovery science, and continue to benefit the University research community at large. For example, AP core resources and expertise aided preliminary studies by research programs involved with the recently awarded Cognitive and Neurobiological Approaches to Plasticity (C-NAP) COBRE in the Department of Psychological Sciences. AP Cores are staffed by faculty and staff who provide expert instruction in their use. AP faculty collaborate with peers in departments throughout the University, including Chemical Engineering; Kinesiology; Food, Nutrition, Dietetics and Health; Apparel, Textiles, and Interior Design. They also offer interdisciplinary training of students from undergraduate to postdoctoral levels. AP faculty members actively promote their discipline through organization of symposia and workshops at national and international meetings (e.g., Experimental Biology, Society of General Physiologists Symposia, Main Meeting of The Physiological Society), service on extramural grant review panels (e.g., NIH, NSF, USDA), editorial boards, and peer-review of manuscripts.

*Cost Effectiveness.* The Program supports Ph.D. student training through graduate research assistantships. Presently, the costs of graduate student credit hours, as well as research projects, are funded 100% by faculty research grants. Thus, The Program is highly cost-effective. During the reporting period, no Central Administration or College of Veterinary Medicine funds were allocated for graduate teaching assistants. Despite the financial limitations presented, faculty with resources to fund graduate student training balance research goals with their commitment to produce outstanding students and future colleagues.