

**Food Science and Technology**  
**Academic Planning, March 2008**  
**(updated: March 2009)**



**Executive Summary**

The Department of Food Science and Technology (FS&T) at the University of California Davis is the only department dedicated to food science in the UC system, and the only PhD-granting department of food science in California. The Department represents a multidisciplinary team working together to improve our understanding and application of the science of food, and is thus similar in philosophy to many of the institutes and centers currently being created within UC Davis. This synergy will be taken to a new level following the Department's move into the Robert Mondavi Institute for Wine and Food Science, with new laboratory spaces, enhanced interactions with the Viticulture and Enology department and new food processing facilities. The Department and its various programs are partitioned among four main areas of emphasis: Food Chemistry/Biochemistry; Food Microbiology/Safety and Fermentation Science; Food Engineering; and Sensory and Consumer Food Science. It offers a diverse undergraduate major with seven options, an MS degree and a PhD degree in disciplines that are applied to food and food-related issues.

Undergraduate and graduate programs in the department are ranked among the top few in the world. Enrollment in our undergraduate Food Science degree is the highest in the nation, and has been increasing steadily over the last several years. Its strength in research and outreach cuts across the spectrum of its subdisciplines. Thanks to the generosity of many donors, the campus has raised just over \$7.5 million toward an \$8 million goal to construct the August A. Busch III Brewing and Food Science Laboratory, a critical teaching and research facility for the UC Davis Department of Food Science and Technology. These gifts in particular testify to our excellent reputation and leadership in the areas of brewing and fruit and vegetable processing. In addition, our program has had particular impact in areas of engineering of improved food materials and advanced characterization methods, in the development of sensory sciences, and in the identification and study of health-promoting compounds within foods. Finally, FST contains a group of premier basic scientists in microbiology, with a particular emphasis on molecular mechanisms of foodborne pathogen virulence and in signal transduction and sensing mechanisms. These are joined by specialists on the leading edge of protecting the safety of our foods, especially in fruits, vegetables, and tree nuts. At the heart of our reputation in food science research is a commitment to advancing basic science and engineering fundamentals—a hallmark of top-tier food science programs nationally.

However, with the long-term budget cuts suffered by our college, the number of faculty has been decreased by attrition to the extent that the number and variety of courses have been reduced. Our program is in a position whereby accreditation from the Institute of Food Technologists (IFT) could be challenged. IFT requires that the key elements of food science education, including Food Chemistry and Analysis, Food Safety and Microbiology, Food Processing and Engineering, and Applied Food Science, be delivered within the context of our departmental expertise in food. Thus, they cannot be "outsourced", e.g., to chemistry or microbiology departments. This is the case, since the food chemistry, food microbiology, etc. in Food Science are unique to food systems.

The Department has already lost considerable research expertise, and without building its faculty in the near future, is also destined to lose its international reputation as a leading research organization. Likewise, the number of and support for Cooperative Extension (CE) Specialists in Food Science have decreased such that several programs are essentially absent, and the University no longer exercises direct influence on practices in these areas of the food industry. The strength of our research, teaching and outreach components are essential to maintain if we are to serve California, the nation and the world in a time of emerging critical issues for food production, safety and health-promotion. We see our program's ability to spur innovation as a particularly critical strength at this time, and one that must be fostered through strategic new hires.

The student-to-faculty ratio in the Department for 2006-07 was 2.6 times the campus average and the highest in the College; the faculty is overburdened with teaching responsibilities. Furthermore, the age demographics of the Department predict a devastating loss of expertise over the next five years. More than 48% of our I&R faculty FTE are over 60 years of age. This is the largest fraction of I&R faculty in this age group on campus, and perhaps in the UC System. To prevent the further loss of teaching expertise and research emphasis, accreditation and international reputation, the Department requires four immediate faculty additions, two each in Food Chemistry and Food Microbiology, followed by recruitments in Food Engineering/Process Engineering and Sensory/Consumer Food Science. Prompted by this requirement, In 2008/09, recruitment actions took place or are taking place for the following three faculty positions: metabolomics (joint with Nutrition), microbiology, and process engineering (joint with Biological and Agricultural Engineering). Also a proposal has been made for a Specialist in Cooperative Extension specializing in dairy food science. Also of high priority over the coming four years is recruitment of a CE Specialist in seafood safety and quality.

FST plans to increase its research programs and capabilities over the coming five years in the following high-priority areas:

- Personalized Food
- Microencapsulation/Nanoscience
- Sensory Sciences Consumer Sciences and Cultural Studies – Foods for the Future
- Dynamics of Pathogens in Food Systems

Many of these areas will entail cooperation with departments in the Foods For Health Institute and the Robert Mondavi Institute for Wine and Food Science, UC Davis Extension, as well as other units on the campus.

### **The Department of Food Science and Technology, the College of Agricultural and Environmental Sciences and the State of California**

The University of California is a PhD-granting research university and as such, is unique among California's public institutions. The task assigned solely to the University is therefore to conduct leading-edge research to provide benefit and guidance to government, industry and the people of California. The University is also charged with educating the children of California and providing a rich educational environment by bringing a diverse, talented faculty together with an equally diverse, promising student body, and making available to them the best possible educational resources. The University has the further responsibility to ensure that the information

available to us is effectively transmitted to industry, the government and people whom we serve via publications and outreach programs.

California is the leading agricultural state in the US, and agriculture is the leading economic enterprise in the state.<sup>i</sup> Food, food processing, storage and transportation as well as consumer preferences and behavior are central to the economy of the state and to the nation. When compared against *countries* in the world, California on its own is ranked between 5<sup>th</sup> and 9<sup>th</sup>, ahead of Mexico, Canada, Germany and Spain.<sup>ii</sup> As a Land-Grant campus of the University of California, UC Davis bears the responsibility for ensuring sustainable sources of food and fiber for the future. A culture is generally defined by its art, literature, architecture and political system. However, an often-overlooked truth is that it is the availability of a safe, stable food supply that enables a people to create and develop their culture. Agriculture is that part of a culture upon which all else is built, and food is the essential product of agriculture.

The science of food is by definition a practical application of basic science to the successful knowledge and technologies delivering society's most essential requirement, food. The University of California, Davis has led the world in food science for 80 years. This expertise, assembled by the state of California, has been a critical asset in building the safest, most nourishing and affordable, and valuable, food supply in the world. The university can not allow this resource to decline.

The effectiveness of our programs—and indeed our service to California—also depends increasingly on the internationalization of our activities. Such a global perspective concretely impacts California agriculture, for example, in the increased value of agricultural exports from our state to the rest of the world, and the increased use of food materials from international sources. In a global society, an international perspective is needed in the curriculum we teach, in our research activities and in our outreach. These activities include study abroad programs for our students, attracting top international students and scholars to study at Davis, engaging in multi-disciplinary research beyond our borders, building strong partnerships with leading food science and technology institutions around the world. Our program has been active in all these areas, including substantial cooperative arrangements with universities in China, Spain, Thailand, Turkey, The Netherlands, and other nations.

In addition to meeting these long-term needs of the State of California, the Department of Food Science and Technology must play a key role in addressing several emerging food issues. These include the impetus to reduce energy utilization and limit or find alternative uses for waste produced by the food industry—both of these goals of particular importance due to environmental concerns. Other issues include the evolving nature of threats to food safety, the impact of biofuels on our ability to provide an adequate food supply, the influence of food products on issues related to obesity and other health concerns, changing food needs for changing California demographics, and the initiative to develop foods for improved health, including doing so on the personal level. Our faculty are taking the lead in many of these areas, but the impetus from newly recruited faculty is needed to sustain these efforts.

The Department of Food Science and Technology at UC Davis is the only PhD-granting Food Science program in California and the only department devoted to food science in the UC system. UC Davis is internationally acclaimed for both its graduate and undergraduate programs in Food Science. It has long been ranked among the top three such programs in the US, and its graduate program was recently ranked second in the world among other universities by [sciencewatch.com](http://sciencewatch.com).

### **Mission of the Department of Food Science and Technology**

The mission of the Department is to generate knowledge about foods through research, and to apply and disseminate knowledge through teaching and outreach, with the goal of ensuring the availability of safe, nutritious, appealing food, with minimum environmental impact, for the benefit of all people. These goals are clearly at the heart of the mission of the College. Achieving the objectives of this mission statement requires success in many endeavors, including research, graduate education, undergraduate education and outreach.

Research in the Department of Food Science and Technology and in the Graduate Group in Food Science covers a wide range of topics and aims. Furthermore, there are two purposes of university research: the research product itself, and research mentoring. PhD-level research, involving doctoral students, postdoctoral fellows and other collaborators, seeks to produce new understanding of a subject that will foster progress that is more than a simple extrapolation of current ideas. Such research may be directly applied to food or a food system, or may be basic research that is targeted toward some issue in food science of the future. This research is also an educational experience that encourages our graduate students and postdoctoral researchers to become the leaders of the next generation of food scientists. They will be the educators, the researchers and the government officials that will define the future of food science, and they will do so according to how they are trained. Masters-level research should contain creative aspects as well. Our program requires Masters students to develop mastery of some area within food science and to apply current knowledge and technology in the most effective way possible. Upon graduation, Masters students will work with industry or government, and advise consumers and consumer groups.

Our undergraduate program seeks to give the students a firm background in science, focusing on but not limited to food, as well as a well-rounded college education. Undergraduate education may or may not include a research component. Our undergraduates are prepared for graduate school, for health-related professional school, or as professionals in the food and pharmaceutical industries. They are also expected to be well-informed consumers.

The results of targeted research as well as the body of knowledge encompassing food science and technology are shared not only with our students, but with many segments of the community. Through collaboration with UC Davis Extension and other campus units, our faculty educates life-long learners through innovative and timely programs. Reliable information must be available for those who deal with all aspects of food, including production, processing and packaging, shipping and storage, retail and restaurants, selection, preparation and storage in the home, and consumption. Outreach activities that target these segments are also essential to the role of the Department of Food Science and Technology, if we are to ensure the quality, safety and defense (biological as well as chemical) of the food supply, from production through consumption.

Our faculty is a leader in food science education for lifelong learners, particularly in collaboration with UC Davis Extension. To address society's priorities and meet the constantly-changing needs of lifelong learners, we are developing and teaching timely and innovative programs such as the extra-virgin olive oil quality and processing short courses and the year-long Professional and Master Brewers programs, and online Applied Sensory Science and Consumer Testing Certificate.

## **Core Competencies in Research**

In order to address our mission effectively, we must have expertise in a broad range of areas and disciplines. Because not all of our students are destined to become academic researchers in food science, the expertise we require for teaching is not identical to our research expertise. It has always been the practice of this department to recruit faculty on the basis of discipline and research area, then partition teaching assignments according to discipline, rather than to recruit faculty to teach a particular course. PhD-level research in food science is a charge given solely to this department by the state of California, and it is therefore our first responsibility. Accordingly, the core competencies in research are discussed, first.

**Food Chemistry and Biochemistry.** Chemistry is the discipline that underlies all of food science. The most fundamental property of a food is its composition, which determines its nutritional value, stability, sensory properties, toxicological properties and potential to support the growth of microorganisms. Analytical chemistry is therefore at the heart of food science. Understanding the interactions among food components, interactions with their surroundings, and how these interactions are altered by conditions such as temperature, moisture and oxygen, require an understanding of physical chemistry. Furthermore, because all food arises from biological systems, a full knowledge of biochemistry and biochemical principles is essential to an understanding of food systems. Hence, food processing, fermentations, sensory analysis, formulations and product development, as well as microbial and chemical food safety are all governed by chemistry. An education in food science and the research effort within a department of food science must encompass rigorous training in chemistry.

Providing this research and training environment requires the following specific areas of technical expertise: analytical chemistry, including spectroscopy, chromatography and electrochemistry; organic chemistry, including reaction mechanisms and structure determinations; physical chemistry, including physicochemical interactions, phase behavior and kinetics; biochemistry, including structure, function and interactions among biomolecules, enzymology, knowledge of plant, animal and microbial systems and metabolomics. Past strengths and future hires may also cut across these technical areas in order to focus on specific areas of food chemistry expertise, such as flavor chemistry or lipid chemistry.

**Food Microbiology.** The biology, ecology and epidemiology of foodborne pathogens remain under-represented research areas in both FS&T and the college. This deficiency is occurring at a time when the citizens of California and the nation are demanding more involvement by the university in educating the public and government about food safety and food defense issues. There is also wide interest in the agriculture and food industries in adding value to agricultural materials through microbial conversion into products that enhance human health. FS&T currently has no faculty member dedicated to the conversion of agricultural materials into specially designed probiotic and nutrition augmenting consumables, marking this as an area for strategic growth. Importantly, probiotic food microbiology is an area that can integrate with food safety to enhance both FS&T and the college's goal to promote areas of food safety and foods for health. The college has identified food safety and foods for health as two areas for investment and growth that will serve a diversity of local, state, national and international stakeholders.

The Department requires core expertise in detection, identification and dynamics of microbial species in food systems, including pathogens, spoilage organisms, and organisms used in fermentations or as food; microbial genetics; microbial physiology and biochemistry,

including mechanisms of adaptation to stress, survival in food processing or storage environments and mechanisms of food associated pathogenesis; and control of fermentations, which is specifically named as a priority in the Charter of the University of California.

**Food Engineering.** Food engineering is one of the key disciplines needed to understand, control and improve the quality and safety of foods. Our program benefits strongly from the ability of the faculty to work at the interface between engineering and physical chemistry, which allows them to study, understand, measure and control the molecular and microstructural properties of foods. By its nature, this research addresses the mission-oriented focus of the Agricultural Experiment Station (AES), CE and stakeholders, including food companies and consumers, because its objectives include increasing food quality and safety, while reducing the environmental impact of food preservation activities. Current research ranges from quantifying and reducing energy, water and raw materials used in food processing, to defining entirely new concepts for adding value to food-processing byproducts and for increasing food quality. Examples include development of magnetic resonance as an on-line processing sensor to detect food defects and assess food quality; edible films to protect foods from oxygen, aroma loss and moisture change; and materials for effective micro- or nanoencapsulation and release of nutraceuticals to improve the aroma, flavor and nutritional value of foods. While fundamental approaches are taken to address problems and develop new concepts, the research projects of the Food Engineering faculty focus on practical problems in food preservation, safety and quality.

The areas of expertise required by this research program include process/package analysis and unit operations; physical chemistry and structure of foods and related materials; sensing and physicochemical characterization; and engineering analysis and modeling.

**Sensory and Consumer Science.** The goal of providing a food supply that is appealing as well as healthful is addressed by our sensory and consumer science group. This issue is especially timely in light of the current epidemic of obesity and related health problems. The perception of flavor, attitudes towards foods and criteria used by consumers to select the foods they eat are central to both dietary health and to strategies for product development, formulation and marketing. Accordingly, the mission of the consumer and sensory science faculty is to explore and develop ways to produce safe, nutritious and wholesome foods with optimal sensory properties and appeal in the emerging areas of food culture and healthfulness, and to train future food producers, developers, scientists and marketers. This campus has long been recognized for its strength in sensory science and consumer science dating from the pioneering work of Profs. RoseMarie Pangborn and Howard Schutz.

Our research in this area is in several core areas: flavor, aroma and sensory perception, including experimental measurement and statistical analysis; consumer behavior, including psychological barriers to adoption of a healthy lifestyle; and consumer metrics, including market research, psychology and statistics as applied to the study of consumer behavior related to foods and beverages. In addition, we seek to advance the field itself by developing and testing models and theories, by developing an understanding of the psychological and physiological variables associated with sensory and consumer measurement, and by using this knowledge to develop more efficient and valid measurement procedures. The specific competence required to achieve these research goals are experimental design and development of methodology for behavioral measurement (controls, biases etc.); developing and testing models of sensory and consumer function; statistical and other analyses (e.g., signal detection, etc.); and critical understanding of sensory and brain function (applied psychology).

## Core Competencies in Teaching

**Goals of Undergraduate Programs.** The undergraduate program provides background preparation in general chemistry and analysis, biological sciences including microbiology, physics, mathematics, nutrition, communications and statistics. It further defines the essential core competencies of food science as food chemistry and analysis, food safety and microbiology, food processing and engineering, and applied food science. These elements of the undergraduate curriculum in food science are also designed to conform to the educational standards for degrees in food science published by the Institute of Food Technologists, the professional body for food science in the USA. Because of the specialized knowledge required to teach these diverse subjects, departmental faculty teaching assignments cannot be readily made across disciplinary lines, and thus a critical mass of faculty are required to cover each of the various core areas. In order to deliver instruction in these essential core competencies, it is necessary to have faculty with experience and expertise in these specific fields, and who also have an awareness of the integrated multidisciplinary whole, as encompassed by the applied discipline of food science.

**Goals of Graduate Programs.** The graduate program is divided into MS and PhD programs. The MS degree predates the PhD program, and has long been held as the standard for food science training by industry; it has never been a degree for failed PhD students. The goals of the MS program are to provide graduate-level courses in the central disciplines within food science (food chemistry/biochemistry, microbiology and processing), plus specialized training in the student's chosen area of interest: Chemistry/Biochemistry, Microbiology, Engineering or Sensory Science. The course work is accompanied by a creative research project in which the student applies the principles of food science or related discipline to some system relevant to the research area of the faculty mentor, in support of the mission of the AES.

The PhD program also requires rigorous core and additional, specialized course work, followed by an intensive research project in Biochemistry, Chemistry, Microbiology/Fermentation or Sensory Science. The research is expected to be of publication quality. Research mentorship is therefore a component of teaching that occurs outside the classroom. A student leaving our program with a PhD degree should be able to survey a research area, identify significant issues or problems in that area, pose questions that address those issues or problems, design experiments to answer those questions, conduct the experiments, and interpret the data. These are the skills that separate a PhD from lower degrees, and these are the skills that are transmitted to the student via research mentorship rather than by course work. Both degree programs teach organizational and communication skills necessary to share complex information with an audience, as these skills are central to classroom teaching, and to outreach activities.

**Chemistry.** Food scientists must be knowledgeable in physical and chemical methods of food analysis, including intended components of the food and contaminants and toxicants of either biological or chemical origin. They must understand the composition of food, including not only the identity of the components, but their structures, functions and mutual interactions, and their contributions to the structure and properties of the food as a whole. An understanding of these subjects requires a knowledge of both organic and inorganic chemistry, and of the physical chemistry of the phases of matter and of dispersions of one phase in another. In addition, because all food is a biological system composed of complex biomolecules, a full understanding of the biochemistry of food is also essential. Only with this expertise can a food chemist understand the structure and composition of food, and the changes that occur in it during

harvesting, processing, storage and preparation. In addition, our students must be trained in chemical safety, both in relation to laboratory work and to food toxicology.

**Microbiology.** If the food supply is not safe, no other property, cost or condition is important. Therefore, the prevention of foodborne illness is a paramount goal of our program. Our students must be adept at the culture and identification of microorganisms, including selective and indicator media, immunologically-based or genetic-based detection/identification techniques, all of which require familiarity with microbial physiology and metabolism. Perhaps more important than detection of pathogens and spoilage organisms is their elimination by proper preservation techniques, which requires an understanding of microbial physiology and ecology. Proper preservation serves two functions, prevention of foodborne illness and reduction of economic loss and waste due to spoilage, both of which are AES priorities.

Fermentation, essentially a variety of processing, alters the flavor and properties of foods or beverages, and creates new products, lending a substantial value-added component. Fermentative microorganism can be viewed as preservation agents, as they may decrease pH, deplete carbon and energy sources for undesirable organisms, produce alcohol, or simply compete with spoilage or pathogenic organisms. Consequently, an understanding of the fermentation process and its control, as well as the interactions of microbes in complex systems is necessary. Fermentations, the first biotechnology, can be altered, optimized and controlled, often by genetic manipulation. A fundamental understanding of genetics and genetic manipulation, as well as genetic research tools forms a significant portion of the competencies required of our students.

**Engineering.** Food engineering involves the fundamentals of transferring heat to or from food, mixing and movement of product, describing component or waste streams, rates of chemical change, and transport of food components into and out of the food and across packaging materials. The fundamental energetic descriptions of the food determine the thermodynamic drivers for these kinetic processes. To understand these general subjects, our students receive instruction in the fundamentals of engineering thermodynamics, chemical kinetics, fluid mechanics, conduction, convection, and radiative heat transfer; microwave heating, refrigeration, freezing, psychrometrics; mass transfer during drying and storage; and Newtonian versus non-Newtonian fluid properties in relation to momentum transfer. The application of the principles of mass transfer to rates of quality changes of foods is also covered in food processing courses. Our packaging curriculum includes concepts of material science, food shelf life, indices of food failure (unacceptability), deterioration kinetics, mass transfer, tamper-evidence and food packaging law in analyzing and designing packages for food safety and quality with minimum impact on the environment. IFT requires that packaging be covered in an accredited Food Science curriculum.

**Sensory and Consumer Sciences.** The core competencies that must be transmitted to our sensory and consumer science students include sensory theory and methodology, sensory function and brain information processing, experimental design and sensometrics—the application of statistics to sensory and consumer science, and modeling. Our consumer science students must be knowledgeable in the areas of food culture, consumer acceptance, preference testing and optimization, factors affecting acceptance, as well as economic and marketing considerations. Sensometrics, models and analysis are also an implicit part of our program.



## **Core Competencies in Extension, Outreach, and Lifelong Learning**

The Department has had a strong Cooperative Extension program with both commodity and discipline strength. In the 1990's through the first part of the 21<sup>st</sup> century we had 7.3 FTE, with expertise in microbiology (3.0 FTE), technology (2.0 FTE) toxicology (1.0 FTE) and consumer sciences (1.0 FTE). Specialists worked closely with the meat and poultry industries, dairy industry, fish and seafood industries, fruit and vegetable processing industries. Their leadership helped these industries stay abreast of scientific advances that affected their commodity, enabled the industry to maintain a safe, affordable, high quality food supply, and strengthened California's economic base. The Department has contributed to this leadership by developing and offering timely and innovative programs such as the extra-virgin olive oil quality and processing short courses and the year-long Professional and Master Brewers programs, and online Applied Sensory Science and Consumer Testing Certificate.

Our CE Specialists have established several centers, including the Center for Consumer Research, FoodSafe, and the RMI Center for Fruit and Vegetable Quality; and they participate with several faculty in the Center for Advanced Processing & Packaging. One of our specialists is associate director of the Western Institute for Food Safety and Security. All specialists provide industrial referral and consumer information on a broad scale for use by anyone from home canners and cooks, to foodservice operators, industry, regulators and entrepreneurs.

We launched and have been able to maintain the Seafood Network Information Center (SeafoodNIC) since 1997. SeafoodNIC is a portal to Internet resources addressing seafood safety and quality information needs of seafood processors, inspectors, researchers, importers, and food educators. It has over 6,600 seafood related files, and receives about 20,000 unique visitors per month. Viewers from over 100 countries use the site as a key reference for industry, regulatory, academic, reporters, and consumers.

However, because of sustained budget cuts, by 2003 the number of CE Specialists in Food Science had been reduced by 3 FTE to 4.3 total, with an additional retirement expected within the next 5 years. While each of the remaining CE faculty members has achieved national or international recognition for excellence in their field, fewer commodities receive direct assistance, with only 1 FTE for processed fruits and vegetables, and 0.3 FTE for dairy. One specialist focuses on microbial food safety (primarily of fruits, vegetables and tree nuts), another on consumer behavior, and one specialist focuses on policy issues. All are involved in industry or public educational programming. Disciplinary strengths include plant physiology, engineering, toxicology, microbiology and consumer sciences.

## **Overview of Current and Anticipated Shortfalls in our Ability to Deliver Research, Education, and Outreach**

While the campus has sought to build top-ten-ranked programs in other fields, it has not been so careful to maintain a program that was already ranked among the top two or three. Despite a talented group of faculty, our inability to recruit has meant we have simply not replaced faculty or CE specialists, and we have lost entire research and outreach programs. A second impact of our attrition is that a smaller faculty is forced to cover the essential functions of the department and graduate group, including teaching and committee service, so that they become less productive in their research than without the added burden. As a result, faculty productivity has declined, although the quality and impact of our work remains high, as assessed by sciencewatch.com.

Our staff available for teaching has fallen below a critical mass, so that our faculty have exceedingly high classroom commitments, and a single sabbatical leave can create difficulty for remaining faculty. Retirements and the increased teaching requirements they have created have led to our having to hire a temporary lecturer to teach FST 160, Product Development, which was designed to be our *capstone* course. FST 108, Food Plant Sanitation, is no longer offered. We no longer teach a graduate course in Food Proteins, and we offer no graduate laboratory classes. In part because of the loss of critical mass of food microbiology faculty, it may be necessary to limit enrollment to our own students in FST 104L, Food Microbiology Laboratory, which has been an important service course for the campus.

Recent data on Student-to-Faculty Ratios (SFR) on campus demonstrate that our faculty members have been teaching much more than their share. Although the College faculty as a whole have higher teaching loads than the campus average, the Food Science faculty are at the extreme. As of 2000-01, FST faculty had an SFR more than 25% above the campus average, compared to the aggregate numbers for the College, which were only 6% above the campus average. A steady rise has been observed since then, with a steadily increasing gap between FST and averages across CA&ES, so that in 2006-07, the SFR for FST faculty was more than 2.6 times the campus average and 2.3 times the average for CA&ES. Projected data do not suggest relief. Our current staffing level of 14.60 FTE (I&R + AES, as of 10/01/07) is very near our target of 14.70 FTE.<sup>iii</sup> As of October, 2007, an additional 2.3 FTE have been allocated, although these involved recruitment by initiative, and thus were not designed to address our most urgent programmatic needs. Of these 2.3 FTE, 0.5 FTE is for sociological aspects of food (position filled), 0.6 FTE is for a food process engineer (recruitment completed), 0.35 FTE is for a metabolomacist (recruitment in process), 0.2 FTE is for a biosensor engineer, and 0.65 FTE is for a consumer scientist. These positions will strengthen food science at Davis, and the engineering candidates in particular have been selected with the intent that they can help us with our future teaching needs in food engineering/processing. However, none of these positions address our imminent and critical shortfalls (see below) for staffing our current microbiology and chemistry courses, or respond to threats to our core competencies in these areas. Our projected SFR for 7/01/08 using projected FTE is 38.15, and that using target FTE is 48.90: by either criterion, these levels remain the highest in the college. The Department is now, and is projected to remain at the upper end of the SFR scale for the campus. This fact indicates that our target FTE values are *unrealistically low* compared to our teaching load, especially since recently-allocated FTE do not contribute their full weight toward our most critical teaching needs.

**Projections of Future Retirements: Faculty Demographics.** Beyond currently-planned retirements (1.0 FTE (chemistry) in 2007/2008 and 1.0 FTE (microbiology) in 2008/2009), the Department can anticipate further retirements by examining our demographics. Specifically, in the next five years, we can expect many if not most of the faculty who are now 61 years of age and above to retire. The data (Age Distribution-Ladder Faculty, October 2007) show that 48.6% of our I&R FTE fall in this category. Not only is this percentage the largest in the College, it is the largest on the campus. With the exception of Human and Community Development's percentage of 43%, no other department has more than 40% of its I&R faculty over the age of 60. In contrast, only 26.4% of the individual faculty in the college are in this age group, while the average percentage over CAES departments is only 8.6%. We are therefore the most likely department to lose faculty, and we are likely to lose the most faculty to retirement or age-related health issues in the next five years. *Recruitment must be begun before these retirements occur*

*in order to prevent temporary but devastating gaps in our ability to accomplish our research, teaching or outreach missions.*

**Involvement of CE Specialists in Teaching.** Cooperative Extension Specialists who have active research programs are permitted to join the Graduate Group in Food Science; those in our department have been given adjunct appointments, and are therefore able to mentor graduate students. However, CE Specialists hold a unique position in the department, because travel is often an essential part of their program. The expertise of CE faculty is highly valued by the I&R faculty, and CE Specialists are often asked to participate in classes as guest lecturers. With current CE FTE 60% of what it was in 2000, these faculty have already taken on additional extension responsibilities to fill some of the gaps. It is not appropriate in most cases for current CE Specialists to take on additional teaching responsibilities in the department to fill gaps resulting from I&R faculty retirements. It is inconsistent with the charge of most CE Specialists to serve as Instructor of Record for regular classes, because it would reduce their interactions with their primary clientele and diminish their effectiveness. Enlisting the help of CE Specialists in regular teaching therefore represents a false economy, alters the distribution of services that are to be curtailed, and drains funding for I&R FTE. The Department has provided flexibility toward individual specialists in accord with their individual needs and responsibilities.

#### **Identification of Specific Shortfalls: Current and Projected Gaps in Core Competencies**

Gaps in our core competencies already exist, their number is increasing and will increase more rapidly over the next five years unless we act aggressively. The gaps must be filled in order for us to teach our courses. But the necessity of maintaining a critical mass of faculty in the subdisciplines of food science must also be stressed. Collegial interaction is always synergistic, and is particularly so in food science, which relies on the combined efforts of core subdisciplines towards the common goal of understanding and improving foods. Interaction among graduate students in different laboratories substantially enriches their education. The faculty of FST are in danger of becoming isolated, we have lost a critical mass of faculty in food chemistry and biochemistry, and we are about to lose our critical mass in microbiology. Although biological science has grown substantially in the last two decades at Davis, the growth has occurred in CBS, and has become increasingly removed from agriculture. Hence, re-establishment of a critical mass of CA&ES faculty in essential research areas and collocation of their laboratories to foster sharing of ideas, expertise and equipment are essential if the College is to thrive. Gaps can therefore be larger than they appear, and cannot be filled by scattered hires.

Both existing and projected gaps are listed below, by discipline.

**Food Chemistry and Biochemistry.** We currently lack organic chemists or analytic chemists with expertise in carbohydrate or flavor chemistry, or sufficient expertise to teach students about formulations chemistry. One of our lipid chemists, who teaches a substantial portion of our graduate food chemistry course, is a part-time volunteer with an adjunct appointment. We have no biochemists specializing in plant systems, meat or seafood. The retirement of one of or two physical chemists occurred in 2008. Our last recruitment was for a biochemist, and was halted in 2002 midway through the process. A recruitment for a chemist/metabolomicist (joint with Nutrition) is underway in 2008-09 to partially fill the needs in chemistry. This is a 35% FTE position in FST. The addition of Dr. Seiber, a chemist, to the department chair position in 2009 will help as well, although the Chair's position is primarily an administrative position.

**Food Microbiology.** Upon the announced, imminent retirement of two of our three I&R microbiologists, we will have difficulty covering our essential courses, and we will lose our only faculty member specializing in yeasts and industrial fermentations. The second scientist studied general microbial stress responses, which affect the growth and survival of several food pathogens. Hence food biotechnology and fermentation other than brewing are areas in which we are seriously deficient. A recruitment for a food microbiologist is underway in 2008-09 to partially alleviate this need. Food safety is a crucial area for industry and for the people of California, and requires more emphasis. In addition, the department houses the Phaff Yeast Culture Collection, one of the five largest public collections of wild yeasts in the world, with over 7,000 strains belonging to over 500 different species (roughly half of the known yeast species). This collection is an important biodiversity resource, and needs continued support.

**Food Engineering.** Our chemical engineering faculty are currently adequate in number. However, the announced retirement of an engineer with a 20% appointment in FST who has provided more teaching hours than his appointment would suggest, will weaken our program. An additional retirement will make it difficult to cover our courses. The approaching retirement of one of our physical chemists who works at the interface of physical chemistry and engineering will create a deficiency in our processing and food properties expertise, and weaken the link between engineering and physical chemistry which is such an exceptional strength of our program. Specifically, food material science, food structure and component interactions will be areas of weakness. Recruitment of a Food Engineer (50% FST and 50% BAE) was recently completed with a start date of July 1, 2009.

**Sensory and Consumer Science.** This program is currently strong, especially if we include members of other departments who contribute to our graduate group. However, the recent retirement of a consumer scientist has left a gap. This loss is an important one, in light of the Foods for Health initiative, and a consumer scientist involved in consumer metrics, nutrition or food choice would be a valuable asset to the initiative.

**Curricular Development.** With the shortage of faculty in the department and the current SFR values for the existing faculty, it is appropriate to plan for new emphases, courses or programs unless resources to support them are available. Faced with the prospect of zero growth for the next few years, we should perhaps be planning which activities we can cut from our program. Our departmental teaching committee spends its time planning how to meet our existing commitments with diminishing resources, rather than in designing new courses or programs.

With a modest increase in resources, including FTE, the department would be able to institute several improvements in our curriculum. These include restoration of some of the courses that we have had to cancel, such as Plant Sanitation, Food Law and Food Proteins. We would establish new courses in Consumer Food Science and Functional Foods, both in support of the Foods for Health initiative. The department would consider redesigning, or perhaps dividing our graduate Food Microbiology course so that it would be more effective for students who are not microbiologists, while providing greater challenge and depth for our microbiologists.

All recruitment actions will search for the best scientist available within the general research area of the search, and the application of research effort toward goals of the AES will be stressed during the recruitment process. It will be made clear that advancement as well as summer salary (AES 11-month appointment) are intrinsically linked to service to the mission of the College and AES.

**Cooperative Extension Specialists.** Significant gaps in the service we provide to the people of California already exist in the areas of dairy, seafood, animal protein, food ingredients and process engineering. Dairy science has been well represented in our department but has declined sharply. Yet California leads the nation in milk ice cream and cheese production, and milk is our state's most valuable agricultural commodity.<sup>1</sup> Especially because of changes in the dairy industry over recent years, a Dairy CE specialist is critically needed to develop innovative training programs that target employees of dairy processing plants. Further, such a specialist is needed to conduct research with the goals of stimulating product innovation, improving process efficiency and reducing environmental impact, and advancing dairy product quality and healthfulness.<sup>iv</sup> A proposal for a CE specialist in dairy processing was submitted to CA&ES in February 2009 to address needs and opportunities.

At the time of the retirement of the seafood specialist, the Food Science and Technology Department identified replacing the position as a high priority. The Extension outreach needs of the seafood industry in Hazard Analysis and Critical Control Point (HACCP) education are being met by an experienced academic coordinator who is scheduled to retire; however, there is no seafood technology processing research in progress within the entire University of California statewide system. Furthermore, the seafood specialist and program representative were a complementary and successful team; with half the team departed, the level of continued outreach has been sorely compromised. When the academic coordinator retires in the near future, the need for seafood research and outreach will be acute. For example, the resources developed within SeafoodNIC are tremendous, but are valuable only if the site is consistently updated. The academic coordinator developed and maintains the site along with a CE Specialist who is no longer with us, and thus the retirement of the former without replacement will jeopardize this and other programs of great value to California.

### **Faculty Priorities – Recruitment**

To avoid the imminent loss of our ability to deliver quality research, teaching and outreach, the Department of Food Science and Technology urgently requires at least four new faculty FTE immediately and two more in the near future. In light of the facts that a recruitment requires essentially one academic year, and that new faculty are not functioning fully as either teachers or researchers for two or three years after hire, these recruitments must begin now.

Our priorities for immediate recruitment are given below. The department expresses the strong sentiment that the first two recruitments must be initiated immediately, the second two might be delayed until 2009, and the Engineer and Consumer Scientist could be recruited in 2010.

**1. Food Chemist, to be recruited in 2008-09.** A recruitment for a chemist/metabolomics candidate is underway jointly with Nutrition as part of the FFHI, to partially address this need. The incumbent will be 35% in FST (primarily I&R) and 65% in NUT. The position description will be kept flexible, to include any of the gaps in core competencies identified above, and to allow us the freedom to choose the researcher with the greatest scientific potential amongst a large pool of applicants. Even with this recruitment, a full-time Food Chemist, solely or primarily in FST is needed. An ideal candidate might be a physical organic chemist who studies structure or interaction of food components, reaction mechanism or food properties. The teaching assignment associated with this position would be determined by the area of expertise of the successful candidate, but would likely include any of our food chemistry/food properties courses: FST 1, 10, 100A (now taught by an engineer), 100B, 101A, 101B, 103, 160 (now taught by a

outside lecturer) 201, 202 (now taught by an engineer), 210 (not currently offered) or 211. Maintaining continuous staffing for FST 10 now requires the assistance of an outside lecturer for some quarters. Currently, a planned sabbatical leave or an unplanned medical leave requires extraordinary measures if these classes are to be offered. Depending on the exact expertise of the individual recruited for this position, the food chemist might address problems in agricultural sustainability, biobased materials, environmental and human health, food safety or even science policy.

**2. Food Microbiologist, to be recruited in 2008-09.** A recruitment for a food microbiologist (1.0 FTE in FST) is underway in 2008-09 to fill this need. A strong candidate will be recruited who studies either fermentations or food safety in the context of complex microbial systems. This new faculty would participate in the rotation of the microbiology courses, FST 104, 104L and 204, and would allow the development of the more specialized graduate food microbiology sequence described above. This recruitment should also enable us to continue to offer FST 104L as a service course for other majors, and also possibly reinstate FST 205, Industrial Microbiology. Our new food microbiologist would be expected to contribute to the food safety, environmental and human health, biodiversity, complex microbial ecosystems, or even biobased materials goals of CA&ES.

**3. Food Chemist, to be recruited in 2010-11.** The exact description of this position would be determined by the program of the first Food Chemist, and would complement that program by filling one of the related gaps. Flavor, food formulations or food properties are likely areas to target.

**4. Food Microbiologist, to be recruited in 2010-11.** The position description would include areas complementary to those included in the program of the first Food Microbiologist.

**5. Food/Process Engineer, to be recruited in 2008-09.** A recruitment in 2008-09 has successfully identified a candidate to fill this need in part. This recruitment is shared with Biological and Agricultural Engineering. This recruitment will be in the area of food and materials structure/physicochemical properties. While the recruitment is essential in order to maintain our teaching program, the new engineer would also specifically address the biobased materials goals of the College and would clearly join the Foods for Health Initiative. However, it might also be anticipated that a process engineer's program could strongly contribute to agricultural sustainability, as new materials and new products may require new raw materials, enable reductions in energy use or waste generation.

**6. Sensory or Consumer Scientist, to be recruited in 2010.** There is an immediate need for a new position in Consumer Behavior with disciplinary expertise in consumer psychology or related field to focus on understanding barriers to the adoption of healthy diets and lifestyles. Teaching by this scientist would include an upper division consumer science course (formerly CNS 100) and a graduate course in consumer science. This recruitment is the Consumer Science position that has been defined and proposed for the Foods for Health Initiative. It could logically be split between FS&T and Nutrition.

**7. CE Specialists, to be recruited in 2009-2010 and 2010-2011.** It is equally urgent to replace our expertise and CE activity in the areas of dairy and in fish and seafood quality and safety. The tremendous economic value of the dairy industry to California, coupled with the emerging needs and opportunities of this industry, necessitates early recruitment of a dairy CE specialist. A proposal for this position was submitted to CA&ES in February 2009.

California is also a coastal state, and seafood is both abundant and varied (over 350 commercial species), as well as healthful and desirable in a healthy diet. But fish and seafood are also fragile and potentially dangerous. Industry requires science-based advice on quality and on compliance with the FDA-mandated HACCP standards; consumers require education on possible contamination (PCBs, mercury or natural toxins), microbial safety and handling. The loss of existing resources such as SeafoodNIC must also be prevented. It is essential for the University of California to play an active role in informing industry and protecting consumers concerning fish and seafood quality and safety by recruiting a seafood specialist as soon as possible.

### **Toward the Future**

After these recruitments, and with continued replacement of retirees, the Department of Food Science and Technology will be able to fulfill its research, teaching and goals. With thoughtful, targeted recruitments, and reasonable investment in infrastructure, it will continue to produce high-quality, high-impact research, well-trained students and new ideas for the benefit of the people of California for the future.

The department plans to augment its research programs and capabilities over the coming five years in the following areas:

- Personalized Foods
  - The department should pursue excellence in the area of personalized foods. This could be done by aligning our program with other programs on campus, such as the Foods for Health Initiative, engineering, chemistry, nutrition, biophotonics, and others. The aim of personalization of foods include making foods personally healthier, and personally safer, convenient, and delightful. FST would build a better understanding of food properties so that we can assemble foods closer to the individual consumer. Pharmacogenetics, metabolomics, and proteomics are among the tool sets needed to personalize diet and health.
- Microencapsulation/Nanoscience
  - Building on existing strengths in engineering and physical chemistry, we envision a strong future emphasis on designing and characterizing novel nano- and micron scale structures within food materials and systems. Examples include developing microencapsulation properties of biopolymers, designing and developing new food-grade microencapsulation methods, designing and investigating controlled release of desired nutrients and bio-active ingredients from nano- and micro – structures in foods, designing self-assembled nanostructures using edible surfactants, and creating nanoparticles for food safety diagnostics. Advanced tools such as nuclear magnetic resonance imaging, microfluidics, holographic interferometry, small angle x-ray scattering and electron microscopy will be used to understand and control nanoscale features of food materials.
- Sensory Sciences, Consumer Sciences and Cultural Studies – Foods for the Future
  - Through cross-disciplinary collaborations with various campus constituencies, the sensory science, consumer science and cultural studies faculty in the Department of Food Science and Technology contribute to UC Davis' reputation and

excellence in food quality, food safety, foods for health, and food and culture research.

- Food Quality: We investigate the determinants of quality for consumers, experts, and producers and thus enhance our ability to deliver the quality through better ingredients, processes, distribution, storage, and marketing.
- Food Safety: We research attitudinal, knowledge, and lifestyle factors that influence food handling practices by producers, distributors, retailers, and consumers, and in turn, food safety. We also examine the impact of these factors on consumer acceptance of novel technologies that may improve food safety.
- Foods For Health: We research the sensory and cultural determinants of food preferences and intake and the sensory, cultural, and other obstacles to better diets and lifestyles, and thus play a key role in the campus' behavioral nutrition, nutrition education, and public health efforts.
- Food and Culture: Within a model of product variables (sensory and non-sensory), consumer variables (demographics and psychographics) and context variables (everything else) as determinants of consumer behavior, we bring together scientists and humanists to investigate the contribution of cultural factors of food choice, preferences, and intake.
- Dynamics of pathogens in the food system
  - Setting the goal to significantly reduce foodborne illness in the USA requires innovative strategies based on understanding the dynamics of pathogen behaviour throughout the food system. Focused research areas that define mechanisms influencing the ecological, physiological, and virulence capacities of pathogens serves as the foundation for developing, evaluating, and applying this science-based technology and more broadly for evaluating its environmental and social impacts. FST has an exceptional core of faculty researchers on which to build a preeminent foodborne pathogen consortium made up of scientists within the department and from across the UC Davis campus that can tackle regional, national, and global food safety issues with continued research investment. Building on the expertise already in place will place UC Davis as the preeminent source for novel ideas with a positive impact on providing healthy, safe food to the nation and beyond.

These areas will include collaboration with faculty in the departments of Nutrition, Viticulture & Enology, Bio and Ag Engineering, and others, including through campus and DANR initiatives in Foods for Health, Food Safety and Sustainability, and through the Robert Mondavi Institute For Wine and Food Sciences. Extramural support through individual and collaborative grant proposals to agencies and industry will be emphasized to grow research capability. New state-of-the-art equipment is desperately needed to support these programs in the Department's new research laboratories and planned pilot processing plant at the RMI complex. Donation of funds and equipment will be pursued, along with grant funds. A special need exists for increased funding for graduate student stipends and expenses. A larger graduate student recruitment pool is needed for 2009/2010 and 2010/2011 to maintain existing research and to pursue new opportunities such as those mentioned above.



The opportunities to strengthen the Food Science academic program is unparalleled, with the current public interest in healthy foods, new facilities in the department at RMI, and new collaborations fostered through the Foods for Health Institute, Robert Mondavi Institute for Wine and Food Science, and others.

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<sup>i</sup>California Department of Food and Agriculture (2007) "Agricultural Statistical Review"  
California Agricultural Resource Directory 2007, Sacramento, CA.

<sup>ii</sup>Agricultural Issues Center (2006) "Agriculture's Role in the Economy" *in* The Measure of California Agriculture, 2006, University of California, Davis, CA.

<sup>iii</sup>I&R + AES Target from CAES Dean's FTE Reallocation Targets, April, 2004. Target includes enrollment increase from 2005-2007.

<sup>iv</sup>McKinsey Report