

Department of Viticulture and Enology

Academic Plan

May 16, 2008

Mission:

- Discover new knowledge about grapes and wine and apply such knowledge to the benefit of consumers, producers, and the environment.
- Impart current knowledge to our students and teach them to conduct well-designed experiments to discover new knowledge and improve industry practice.
- Extend the results of our research, and that of others, to grape and wine producers in order to improve product value for California consumers and enhance the global competitiveness of the California industry.

Faculty:

Today there are 14 faculty, including 12 Academic Senate members and 2 Cooperative Extension Specialists. Of those, two have minor appointments in the College of Engineering. In the past few years, two faculty members retired and two left for other positions. By 2012, one faculty will be 65, four will be 60 to 65, five will be 55 to 60, two 50 to 55, and two under 50. We have a total of 13.75 FTE (4.7 I&R, 7.05 OR and 2.00 CE), with additional 0.25 FTE in the College of Engineering.

Major Research Goals of the Department:

The primary research mission of the Department is to integrate all available knowledge in order to better understand grape and wine quality, and the integral relationship between the two. These areas of knowledge can be organized in the following broad categories. Positions to strengthen the Department are italicized.

- **Grape genetics.** Marker-based genetic mapping and studies of genetic relationships among *Vitis* cultivars and species. Genetic control and inheritance of economically significant traits, including disease and pest resistance, tolerance to abiotic stresses such as salt and drought, development of fruit composition and response to environmental signals, genetic control of, and physiological influences on, flavor and aroma. Mapping and isolation of genes governing such traits. Incorporation of useful traits into rootstock and scion cultivars by both traditional and biotechnological methods. Walker, *Grape systems biologists*.
- **Grapevine environmental biology.** The effects of cultural practices interacting with specific local soil and climate, and particular grapevine varieties or rootstocks, on genetic expression and physiological changes in the vine that affect grape and raisin quality and yield, and consequent effects upon wine composition. The effects of cultural practices interacting with local soil and climate, and particular grapevine varieties or rootstocks, on efficiency of production systems, including minimizing economic and environmental costs. Fidelibus, Matthews, Smart, Williams, Wolpert, *CE specialist in winegrape viticulture, vineyard systems ecologist*.

- **Fermentation Biology.** The study of yeast and bacterial physiology, functional genomics, modeling of microbial processes, and the application of this information to commercial scale fermentations. Block, Bisson, Mills, *Cooperative extension specialist in enology*.
- **Winemaking technology.** Analysis and development of production techniques and equipment and the effects of those techniques on must and wine composition. The integration of processes and systems to optimize product goals and minimize economic and environmental costs. Block, Boulton, *Process chemical engineer, CE specialist in enology*
- **Chemistry.** The study of the chemical composition of grapes and wines using innovative methods for analysis of volatile aroma and nonvolatile taste compounds as well as complex macromolecules that control the flavor and color of wine. Understanding of the chemistry of grape and wine constituents with respect to their health effects in combination with links to food and plant chemistry, nutrition, and medical science. Adams, Ebeler, Waterhouse, *Grape Systems Biology in Flavor Chemistry*
- **Sensory Science.** Development of methods to measure wine sensory properties and understand mechanisms of sensory perception and consumer preference behavior. The integration of sensory and consumer information with chemical composition and treatment variables to understand effects of fermentation technology, grapevine biology, and genetics on grape and wine flavor. Heymann, *Consumer perception sensory scientist*.

Clusters of Excellence:

The combination of diverse disciplines in one department makes viticulture and enology a self-contained interdisciplinary cluster of excellence. These disciplines include plant genetics, plant physiology, microbiology, natural products chemistry, process engineering and sensory science. The new Robert Mondavi Institute will greatly facilitate our ability to collaborate with other faculty on campus. Active external collaborations exist with food science, nutrition, medicine, plant science, nematology, plant pathology, engineering, and other departments. Current majors projects:

- **Sustainable Viticulture.** Viticulture is moving into an era of increased environmental awareness and decreased pesticide use. Economic and quality consciousness are also pressuring growers to farm more precisely to achieve quality goals and profitability. Cultural practices and improved rootstocks and disease resistant cultivars will be needed to meet future environmental and production standards. The Department is collaborating with the Departments of Plant Science and Biological and Agricultural Engineering and is preparing to expand in to this critical area.
- **Flavor.** Chemists, sensory specialists, biochemists, physiologists and geneticists will interact to address the environmental, genetic, physiological and biochemical aspects of flavor development and optimization. The Department is poised to lead this key research area and this effort will be greatly enhanced with the addition of a Systems Biologist/Metabolomicist and a Flavor Chemist.

Teaching Programs of the Department:

Both Bachelor of Science and Master of Science degrees in Viticulture and Enology are offered. The department's classes also serve students in Food Science, Horticulture and Agronomy, Crop Science and Management, and Agriculture Management and Range Resources. Many Ph.D. students are supported via graduate groups, including Agricultural and Environmental Chemistry, Microbiology, Ecology, Genetics, Horticulture and Agronomy, Plant Biology, Soil Science, Plant Pathology, Food Science, Chemical Engineering & Materials Science, and Biochemistry & Molecular Biology. Undergraduate numbers have grown from FY01-02 (96) to FY07-08 (110) while graduate numbers have declined from FY 01-02 (75) to FY07-08 (40).

Effective teaching in our curriculum requires expertise in vineyard establishment and maintenance, wine fermentation, post fermentation processing, and chemical and sensory analysis. Current teaching needs include winery waste processing, sensory science and viticulture specific courses on soils, precision agriculture and irrigation management.

Outreach/Extension:

The Department critically needs new CE positions to address industry needs and to renew the extension of campus research to industry users. The need for dramatically expanded extension activity is of the utmost importance. The primary clientele are producers in the wine and grape sector including support companies such as nurseries and processing suppliers. Department members solicit suggestions for research and current problem issues, and provide research information and problem-solving advice for all facets of grape production: rootstocks, dried fruit (raisin), fresh fruit (table grape) and winegrape industries and all aspects of juice and wine products including: table wine, fortified wine, distilled beverages (brandy, eau de vie) and juice concentrate. The transfer of technological advances is established through the Division of Agricultural and Natural Resources county advisor network and via presentations at county advisor and trade meetings and in trade publications, extension courses (which have a national and international attendance), press contact, web-based resources, testimony and advice to governmental agencies, research proposals and reviews, viticulture and enology journal publications, and direct contact with producers.

Program Impact/Ranking:

Viticulture and Enology continues to be the only such program in the United States that integrates research, teaching and extension. Its graduates are the backbone of the \$32 Billion California grape and wine industry, and hold national and international leadership positions. Our research programs are strongly supported by the wine, as well as the table grape, raisin and grape nursery industry in California. Research results from the Department are widely adopted by the industry and followed closely by scientists worldwide. Department scientists also make fundamental contributions to their individual disciplines. Our graduates lead academics and research programs in many related international institutions. The Department is generally considered to be one of the leading university programs in the world and we constantly receive requests for cooperative agreements from international delegations and academics.

There are now increasing numbers of viticulture and enology teaching programs in CA at the state university level (CSUF and CPSLO) and in other states (OR, WA, NY), as well as at the Community College level in CA (Santa Rosa, Napa, Alan Hancock) and many elsewhere. These programs attest to the strength of the wine and grape industry, and programs with teaching and research perspectives and look to us as the national leader and a source for their faculty. Filling our Departmental needs is essential to the maintenance of our leadership position.

Extramural Grants and Gifts:

Annual direct expenditures of \$2M (FY06-07), primarily from California commodity organizations and state and federal support for viticulture and enology research, with some federal and commodity support for more basic research.

Positions Needed to Achieve Research, Teaching and Extension goals: Critical Gaps in Current Faculty in Priority Order

1. **Cooperative extension specialist in enology.** There are now more than 2000 bonded winery businesses in California which have an economic impact of over \$50B in California alone. This number has more than doubled and the value of their production quadrupled in the past 15 years. Most of these new wineries are small family businesses with few employees who have negligible technical skill, but who produce high value wines. They are distributed across the length of the State and we do not have a single extension enologist to support this high value agricultural product. There is a critical need for the ongoing education of, and technology transfer to this clientele, especially in matters of: fermentation, sensory analysis, wine defects, water usage, and winemaking science and technology.

- 2,3. **Grape systems biologists.** The power of functional genomics to identify the DNA sequences controlling form and function and the existence of a grape genome sequence is revolutionizing research in grapevine biology. Strong teams have already emerged in Europe and Australia and a framework for international coordination of these efforts has been established (<http://www.vitaceae.org>). Although valuable bioinformatics support is currently being provided by the CAES Genomics Facility, UC Davis is not yet a major player in grape genomics research. Strong research groups in other countries now threaten the historic leadership of UC Davis in grapevine biology.

If UC Davis is to be in the forefront of international grape genomics research, two faculty positions must be dedicated to this area as soon as possible—one focusing on fruit composition and wine quality and the other on sustainable viticulture. One is needed to fill a critical gap and the other to strengthen the faculty.

A. Flavor Chemistry: The profound influence of environmental factors and cultural practices on grape berry composition and wine quality will ultimately be explained by defining the metabolic networks that link genomic content to an enological outcome. A systems-based linkage of transcriptomic, proteomic and metabolomic data on grape will

bridge our current expertise in breeding, environmental physiology and biochemistry.

B. Sustainable Viticulture: Grapevine response to pests and pathogens will be understood at its most fundamental level by investigating genome-wide gene function in response to biotic challenges. The elucidation of defense responses and signaling pathways will support existing research activities in breeding for pest and disease resistance.

Both areas present challenging research questions of immense economic significance that are amenable to functional genomics approaches. Both are comparably critical to the mission of this Department, would help build this area of excellence on campus, and would be able to take full advantage of the campus metabolomics facility. It is proposed that the first grape systems biologist position made available to the Department be defined broadly so as to attract a large pool of exceptional candidates in both areas. After the first position has been filled with the most highly qualified candidate in either of the two areas, the second grape systems biologist position will be defined more narrowly to attract someone who will work in the other area.

4. **Cooperative extension specialist in winegrape viticulture.** The dramatic growth of viticulture has created additional demands to investigate unique cultivation problems and issues in many different new growing areas. The small number of viticultural specialists means that large segments of the industry are not well served. The Department needs additional CE positions to complement our existing specialists housed at Kearney and Davis; these new positions would address Central Coast and San Joaquin Valley winegrape viticulture and likely be housed at Kearney.
5. **Cooperative extension specialist in enology.** To address statewide needs, the Department needs two additional CE enology positions to be able to address winemaking in the San Joaquin Valley, Central Coast and North Coast counties. Many of the newest high-value producers are small family-owned operations with little or no technology base. To sustain this important source of jobs, wealth, and tax revenues, the producers need strategies to reduce their environmental impact, especially water use and grape skin handling.

Joint Appointments to Strengthen the Faculty

- **Process chemical engineering.** Water use and waste composition is a major factor in preserving the California environment. Wineries use a lot of water to clean their equipment, generating a lot of waste carrying byproducts, and high BOD potential. A research program is important in this area, state and federal funds are available for such studies, and this person would provide the teaching backup and relief needed in enological engineering courses.
- **Sensory science, consumer perceptions.** In order to deal with the wine market, producers must be able to understand how consumers perceive their product and how to affect those perceptions. Furthermore, a link between perception studies and the analysis of wine sensory qualities would be of great value.

- **Viticulture systems ecologist.** Successful wine and table grape production systems require an integration of micrometeorological growing conditions in addition to edaphic conditions such as water and nutrient availability, including an understanding of cultural practices that enhance efficiency and long-term sustainability. There is a critical need for landscape scale investigations that address these issues and integrate a continuum of research approaches from the molecular/physiological level to broader scales, and modeling would be a key to success of such a person. This would build on the existing campus and college strength in environmental modeling.

Priorities:

Two retirements and two departures have left gaps in our teaching, research and extension programs. Because of the small number of faculty in each disciplinary area, it is difficult or impossible for other faculty members to cover gaps in teaching and research. The positions above are listed in rank of priority to ensure our continued success.

Projected Resource Needs and Strategies for Achieving our Goals:

A new building to house the Department, the Robert Mondavi Institute and the Department of Food Science & Technology will be completed summer 2008. The visibility of the Robert Mondavi Institute and the high quality of the new space will be a strong incentive to attract high quality faculty members. In addition, a new winery will be built on the same site. This state-of-the-art research and teaching winery will also act to increase the visibility of the Department, with an increase in student and prospective faculty interest.

Given the department's uniqueness and its preeminence nationally and globally, maintaining and enhancing excellence in teaching, research and outreach programs by developing critical infrastructure and resources would bring prestige and great distinction to the college and campus.

Approved by Faculty vote May 16, 2008.