Recommendations of Graduate Program Review – March 4, 2008

1. The Department should have a long-term plan of action for increasing linkages with relevant federal and state agencies, as well as continued linkages with private industry. Such linkages may help with future research funding.

   Progress since review: During the last three years’ annual FST Faculty Retreats, part of the agenda has been devoted to pursue new research funding opportunities. At the 2011 Faculty Retreat, a live video conference was established with four USDA national program leaders in agriculture and food science research, specifically to explore potential future grant opportunities in food quality, food safety, research on specialty crops, and national needs Ph.D. training grants. Department faculty have established several stakeholder groups (Fruit & Vegetable industry; Brewing industry; Wine industry; Cheese and Dairy industry) that are actively involved, give input about research projects, and have provided lobbying support for research funding and highlighting the importance of the department’s education, research, and outreach missions to help preserve Experiment Station funding in the state legislature.

2. The faculty is encouraged to continue to build linkages with other departments within the College of Agricultural Sciences (CAS) and outside CAS, including Business and Forestry.

   Progress since review: Faculty in the Department are continuing to build collaborative relationships with other departments within the College of Agricultural Sciences. Most notable are the following strong research connections: Brewing Science with hops and barley breeding in Crop & Soil Science Dept., Food Chemistry with wheat breeding program in Crop & Soil Science; Flavor Chemistry with viticulture program in Horticulture; FST Enology with viticulture program in Horticulture; Value-Added Fruits and Vegetables with faculty in the Linus Pauling Institute and the specialty organic fruits breeding program in Horticulture; Fermentation Biotechnology with Biochemistry and with the nanotechnology program in Environmental & Molecular Toxicology. Opportunities are emerging with the hire of several new faculty, including the department head of Animal & Rangeland Science and newly-forming collaborations in dairy processing (FST Artisan cheese program) and collaborative opportunities with a newly-approved Food Safety Systems position; meat science and seafood protein
functionality collaborations with the new Director of the Seafood Research and Education Center in Astoria.

Across Colleges and Divisions, several research collaborations are building. One relates to the newly formed (2010) Oregon Wine Research Institute and its emerging connections with faculty in Business. Several faculty in Food Science are members of the Wine Research Institute. The Institute Director (a faculty member in the Department) is interested in forming collaborations with the College of Public Health & Human Sciences. A strong research collaboration has been forged with faculty in the Department of Wood Science & Engineering in the College of Forestry.

The chemistry of cellulose nano-crystals and wood polymer composites is being translated to collaborative research in Food Science with carbon nano-fiber applications for packaging films, compression board made of grape pomace, and analytical techniques to measure polymer film strength. The most notable new collaboration was forged among Food Science, Crop & Soil Science, and the College of Engineering related to the OSU mini-malter project. This involved the construction by students of an innovative piece of equipment for the malting of small batches of barley to test the suitability of limited amounts of experimental varieties for brewing applications. The story was reported in 2011 in the Oregonian: [http://www.bit.ly/lBJt5V](http://www.bit.ly/lBJt5V) and the Corvallis Gazette-Times: [http://www.gazettetimes.com/news/local/article_8c963374-4e0a-11e0-994e-001cc4c002e0.html](http://www.gazettetimes.com/news/local/article_8c963374-4e0a-11e0-994e-001cc4c002e0.html)

3. **Attention should be paid to mentoring and supporting new faculty in their efforts to obtain research funding.**

**Progress since review:** New faculty have been assigned peer mentors who are available to provide discussions relative to research programs, Extension, P&T, and faculty success. During the annual FST Faculty Retreat, we have divided faculty into brainstorming teams to discuss research ideas, ideas for collaborative projects, funding sources, etc. in which new faculty actively participate. New faculty also work with the department head to obtain advice for sources of funding, as well as input and advice on grants. The College offers a grant-writing workshop that new faculty have been encouraged to attend.

4. **The Department should consider establishment of a more organized mechanism for gaining stakeholder inputs to planning. Involving relevant stakeholders may help to highlight the need for additional research funding for the department.**

Department faculty have established several stakeholder groups (Fruit & Vegetable industry; Brewing industry; Wine industry; Cheese and Dairy industry) that are actively involved, give input about research projects, and have provided lobbying support for research funding and highlighting the importance of the department’s education, research, and outreach missions to help preserve Experiment Station funding in the state legislature. The Department is currently working to develop an advisory board primary whose mission would be to provide stakeholder input for strategic planning, employer feedback, and fundraising.
5. The Department should consider developing a comprehensive plan for recruitment of minority students. In particular, the current admission process has the potential to let qualified minority candidates slip through the cracks.

6. The last Graduate Program Review identified the high number of international graduate students. Some progress has been made, but further attention needs to be placed on recruiting domestic graduate students.

7. The self-study document prepared by the Department identified that there has been a drop in Ph.D. candidates over the past four years from 19 students in 2003-4 to 7 students in 2006-7. More energy and attention needs to be paid to recruiting Ph.D. students and to the graduate student experience. The review team felt a lack of enthusiasm among the graduate students and faculty on the Corvallis campus.

**Progress since review (Sections 5-7):** Faculty have been aware of the need to recruit domestic and minority graduate students in order to provide a workforce that satisfies the hiring needs of the domestic food industry. The Department has implemented a process to increase and broaden recruitment of U.S. minority students by identifying/flaring minority applicants on the applicant sheets before they are routed to the faculty. Asian students currently comprise the Department’s major proportion of U.S. minority students. Historically, the department had a predominant population of international graduate students. In 1995-96, the percentage of FST domestic graduate students was 25%, increasing to 38% in 2006-07 at the end of the previous review. The FST graduate student admission profile from Fall 2007-2011 is shown in Table 1. Continual progress has been made in recruiting more domestic graduate students during the past several years, and the current percentage of domestic students is trending around 48%. Over the past several years since the last review, the enrollments have increased from 7 to an average of 13.4 Ph.D. students (see Table 3 following Recommendation # 10). The population of Ph.D. graduate students has stabilized at 75% on-campus, and 25% located in Astoria.

<table>
<thead>
<tr>
<th>Term</th>
<th>New Enrollments</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>M.S.</td>
</tr>
<tr>
<td>2007-08</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>2008-09</td>
<td>10</td>
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<td>2009-10</td>
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<td>2010-11</td>
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<tr>
<td>2011-12</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Average</td>
<td>11.6</td>
<td>9.6</td>
</tr>
</tbody>
</table>

8. Continue the leadership and mentorship of graduate students in the Astoria facility, including the monthly graduate student meetings to discuss research. The graduate students in the Astoria facility were very satisfied with the leadership and mentorship that they experienced. They appeared to be working well as a team, and the facilities were considered adequate.

9. Efforts should be made to continue to develop processes to ensure communication and linkages among on-campus and off-campus graduate students and faculty. This may help to solve the
issue of enthusiasm, given perceived satisfaction with leadership and mentorship in the Astoria facility. Some possibilities include but are not limited to: (a) scheduling on-campus seminars and other similar activities such that they do not conflict with off-campus activities, (b) scheduling off-campus seminars that do not conflict with on-campus activities and courses, and (c) providing a van for students to travel to campus or to one of the off-campus facilities as a group.

Progress since review (Sections 8-9): Continuous opportunities for remote participation of graduate students and faculty in activities occur among campus with the department’s two branch stations at the OSU Seafood Research and Education Center in Astoria, and at the Food Innovation Center in Portland. Due to the distance (3.5-hour drive each way from Astoria; 2-hour drive from Portland), students routinely participate in department, graduate, and faculty seminars by Polycom videoconferencing. They often drive to campus to participate in thesis defense seminars. An annual hands-on smoked seafood workshop is being taught at the OSU Seafood Research and Education Center over a weekend experience. This allows students from Corvallis to visit Astoria to stay over and participate in the event, and serves multiple functions as a learning, social, and friendship-building experience. In the past several years, the director of the Food Innovation Center has encouraged and promoted the opportunity for graduate students to conduct research and product development projects at the Center. An additional way for graduate students at the branch stations to bond with their campus-based colleagues is through their graduate representatives. Two graduate student representatives are elected each year to serve the graduate student interests. Currently one of the graduate student representatives is based at the Astoria Seafood lab, and the other is on campus. The graduate student representatives serve as advocates for fellow FST graduate students, are peer resources of information concerning graduate student life in the department, and help to resolve questions and problems of fellow students.

10. Attention should be focused on increasing the number of graduate advisors and mentoring new faculty into that role. The self-study document noted that five graduate advisors accounted for over 55% of the graduate degrees awarded. Furthermore, three of the five advisors have either retired or have been reassigned to new positions.

Progress since review: Faculty have devoted renewed attention to building the number of graduate advisees in the department. Newer FST faculty hires are contributing to increased productivity in graduate student advising and mentoring. Differences among faculty in the Department continue relative to the size of their research groups and the number of graduate students they advise. This is the directly related to their ability to attract funding, greater difficulties in attracting competitive federal funding, as well as variations in funding emphasis which are related to a particular sub-specialty of food science (e.g., food microbiology vs. food engineering). Faculty discussion has also focused on the relative research productivity merits of hiring post-doctoral scholars or faculty research assistants versus graduate student trainees. However, the rapid increases in the department’s undergraduate majors have necessitated increasing the numbers of TA’s to help teach the numerous laboratory course sections related to the FST major (see recommendation #12).

The department continues to monitor enrollment and graduation metrics relative to FST graduate program performance. Graduate student statistics reported in the previous ten-year
review ended with the 2006-07 academic year for an enrollment of 29 graduate students (22 M.S., 7 Ph.D.) (Table 2). Since the previous review, FST graduate student enrollments remained stable for two years, then increased by over 30% to a total enrollment of 38 graduate students (25 M.S., 13 Ph.D.) in 2011-12 (Table 3).

### Table 2. Food Science & Technology Graduate Enrollments and Degree Rates (Fall 1995 – Spring 2007)

<table>
<thead>
<tr>
<th>Term</th>
<th>Total</th>
<th>M.S.</th>
<th>Ph.D.</th>
<th>Total</th>
<th>M.S.</th>
<th>Ph.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995-96</td>
<td>35</td>
<td>15</td>
<td>20</td>
<td>12</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>1996-97</td>
<td>32</td>
<td>17</td>
<td>15</td>
<td>12</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>1997-98</td>
<td>34</td>
<td>20</td>
<td>14</td>
<td>8</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>1998-99</td>
<td>30</td>
<td>17</td>
<td>13</td>
<td>13</td>
<td>8</td>
<td>5</td>
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<tr>
<td>1999-00</td>
<td>31</td>
<td>17</td>
<td>14</td>
<td>10</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>2000-01</td>
<td>38</td>
<td>21</td>
<td>17</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2001-02</td>
<td>33</td>
<td>16</td>
<td>17</td>
<td>12</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>2002-03</td>
<td>39</td>
<td>14</td>
<td>25</td>
<td>13</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>2003-04</td>
<td>34</td>
<td>15</td>
<td>19</td>
<td>10</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>2004-05</td>
<td>32</td>
<td>19</td>
<td>13</td>
<td>11</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>2005-06</td>
<td>35</td>
<td>22</td>
<td>13</td>
<td>14</td>
<td>8</td>
<td>6</td>
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<tr>
<td>2006-07</td>
<td>29</td>
<td>22</td>
<td>7</td>
<td>11</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>33.5</strong></td>
<td><strong>17.9</strong></td>
<td><strong>15.6</strong></td>
<td><strong>10.7</strong></td>
<td><strong>6.7</strong></td>
<td><strong>4.1</strong></td>
</tr>
</tbody>
</table>

The number of Ph.D. candidates is trending upwards to levels previously achieved in the department over 8 years ago. The number of M.S. candidates exceeds Ph.D. students by a factor of two. The reasons for these increases are redoubled efforts by the faculty to obtain grant funding and recruit more graduate students into the program. Since the previous review, total grants and contracts increased by over 60% from $800,000 to currently $1.3 million. New campus-based programs, such as the Provost’s initiative, were also noted as opportunities to attract greater numbers of outstanding students to the FST graduate program.

11. *The Department must further evaluate 400/500 “slash” courses, and especially examine the consistency with which such courses are taught across the curriculum. Graduate students complained that they have to seek courses through forestry and toxicology to fill out their credit*
requirements. The Department self-study mentioned that all faculty members are expected to
develop a graduate course in their areas of expertise that will be taught every other year. Such
development would provide a great addition to the program.

Progress since review: A core curriculum of required courses is taken by graduate students in
the FST program (see Appendix.) This includes MB 540/541 Food Microbiology, BEE 572
Introduction to Food Process Engineering, and a choice of any two of FST 522 Food Chemistry
Fundamentals, FST 523 Food Analysis, or FST 525 Food Systems Chemistry. These are the core
“slash” courses taught in the Department, and each require additional learning outcomes
and/or assignments for the graduate-level (see Appendix). Additionally, FST Faculty have an
expectation to develop and teach a graduate-level class in their area of specialty every other
year. Thus far, FST faculty have developed three “stand-alone” graduate level courses which
are taught as electives: FST 514 Health Benefits of Functional Foods, Nutraceuticals, and Dietary
Supplements (3 cr.); FST 628 Flavor Chemistry; and FST 641 Processing Wheat and other Small
Grains: A Molecular View. One barrier to developing additional graduate level elective courses
is potential low class enrollments, depending on the number of students in the program at the
time in a particular area of specialty. The department will continue to explore additional
offerings of graduate elective courses in the future, and to partner with programs such as
Environmental & Molecular Toxicology or Nutrition to attract a broader graduate student
enrollment.

12. Efforts should be made to increase teaching opportunities to graduate students, particularly
through increasing the number of Teaching Assistantships. The department should continue to
develop graduate teaching assistants for courses with large enrollments. It would seem that MS
students could be utilized for some of the graduate teaching assignments. A second year MS
student should be capable of picking up some of the TA load, at least for some of the lower level
courses. For Ph.D. students who want teaching experience, the Department could consider
offering course credit in return for teaching.

Progress since review: Since summer 2010, a new departmental teaching requirement was
instated, which requires both M.S. and Ph.D. graduate students in Food Science & Technology to
participate in a structured teaching experience. M.S. students are required to serve as a
Teaching Assistant for 2 credits, whereas Ph.D. students are required to serve as a Teaching
Assistant for 4 credits. This was initiated by a recommendation from the FST Graduate
Committee, following considerable faculty discussion over the period of a year. Key events that
drove this decision were two successive 15% cuts in the College’s FY 2009-2011 Experiment
Station budget, and a difficult period resulting from this starting in FY 2009, during which all
department-funded Teaching Assistantships were permanently eliminated. Assessment of
student performance for the new department teaching requirement is by the lead instructor for
the course in which the student is participating. The objective of this requirement is to provide
students an opportunity to improve their basic knowledge and communication skills within their
scientific discipline. Graduate students who have academic career objectives will also be able
to document the teaching experience on their transcripts. When FST graduate students serve as
a TA, they register for the Teaching Practicum class (FST 509 or 609) and receive course credits
with a letter grade. Each student will be observed in their teaching experiences by a Food
Science & Technology faculty member as part of their professional development. All teaching observations will be shared with the student.

13. **The previous Graduate Program Review identified a concern about the lack of consistency in communicating information about the program requirements, particularly the preliminary written exams. Concerns still exist regarding the qualification exam. The purpose and the rationale of this exam were not clear to the review team. The multiple levels of screening and testing of graduate students seem unnecessary. It is suggested some streamlining could take place and not utilize the “optional” exam. The present approach also seems to leave the program open for criticism as arbitrary**

**Progress since review:** Since the last graduate program review, the preliminary written examination requirement was eliminated for Ph.D. students in the FST graduate program. This preliminary written exam was typically administered after graduate students had completed their coursework, usually in the second year of their program, and often involved development of a research proposal on a topic related to, but different from, their thesis project. The purposes of this previous written exam were to evaluate the student’s qualifications as a Ph.D. candidate, to identify deficiencies in the student’s training, and to prepare the student for the oral preliminary exam.

After evaluation of the Ph.D. degree requirements by the FST Graduate Committee, it was decided that the purpose for the preliminary written examination was redundant with that of the Ph.D. qualifying examination that was instituted in 2006. The purpose of the qualifying exam is to evaluate a student’s qualifications and potential for success in the Ph.D. program. Qualifications include competence in basic and applied sciences, ability to discuss and evaluate scientific research relevant to Food Science, ability to formulate and express ideas, ability to critically evaluate the food science literature, and ability to speculate intelligently. The no more than two-hour exam consists of a student preparing a 15-20 minute PowerPoint presentation critically evaluating a research paper selected by the committee from the relevant literature close to the student’s area. The oral presentation is followed by an open-ended discussion and questioning by the committee, which is meant to serve as a catalyst for a broader discussion about how one asks scientific questions, designs experiments, and evaluates data. Therefore, the exam assesses the student’s scientific understanding of food science principles and their critical thinking abilities, and does not focus exclusively on the paper. The examination committee consists of two members of the FST Graduate Committee, plus three FST faculty on a rotating basis, excluding the student’s major professor. Because of the high amount of service effort and degree of FST specialization required, faculty from other departments do not serve on the FST qualifying exam committees, however they routinely serve on our graduate students’ thesis committees. Additional details about the FST qualifying exam are found in the FST Graduate Handbook: [http://oregonstate.edu/dept/foodsci/graduate/Y%20GradHandBook2011-12.pdf](http://oregonstate.edu/dept/foodsci/graduate/Y%20GradHandBook2011-12.pdf)

14. **The previous Graduate Program Review identified that the FST seminar program was of concern. Over the past years no major restructuring has been done. There appear to be no scheduled seminars, and when they do occur, they are not well attended by faculty or students. Both**
students and faculty expressed interest in improving the current seminar status, and this should be given priority attention.

**Progress since review:** The department has put renewed efforts into offering several FST seminar series. The Fall seminar series include presentations by FST faculty and outside speakers. Since many of our faculty have overlapping interests in Fermentation Science, the Food Science seminars are co-sponsored with the Wine Research Institute. The graduate student seminar series is scheduled during the Winter and Spring quarters (see example schedule for Spring 2011 in Appendix). A change since the review is that all M.S. and Ph.D. students are required to register in FST 507/607 Graduate Seminar for both Winter and Spring term (2 credits required), for which they receive a letter grade. Students enrolled in the seminar class who are not presenting will receive a P/N grade, which is based on attendance (>80% attendance = P grade). Additional details are provided on pages 9 and 15 of the FST Graduate Handbook: [http://oregonstate.edu/dept/foodsci/graduate/Y%20GradHandBook2011-12.pdf](http://oregonstate.edu/dept/foodsci/graduate/Y%20GradHandBook2011-12.pdf)

15. **Graduate students must find a funded lab to undertake research, and there are no rotations within labs and disciplines.** This may lead to issues as to exposure of students to the various science and technology techniques and approaches as well as possible personnel conflicts. The Department should consider instituting some form of lab rotation process for graduate students.

**Progress since review:** There was considerable discussion about this idea among the department faculty. Whereas from an outsider’s perspective a rotation process may make sense, there was a general consensus that the different non-intersecting disciplinary programs (chemistry, microbiology, engineering) within the department preclude this from easily being implemented. In specific instances where the graduate student’s research project has an interdisciplinary focus, cross-training is already occurring (for example, between flavor chemistry and dairy processing; or small fruits and horticulture). However, an across-the-board rotation process was viewed as difficult to implement. Many of the research deliverables for commodity-funded projects are on tight scheduling, and student research productivity would be negatively affected in some cases. In other instances, there are large variations in funding among the different research groups in the department, which prevents rotation from happening easily. We will continue to be aware of this opportunity, but at present time don’t envision an easy mechanism to implement it as a standard graduate student training practice.

16. **The Department should continue to conduct annual reviews with graduate students. It can help to keep graduate students on track and can serve to “catch” struggling or failing students.**

The FST graduate faculty adhere to this policy as a standard practice. The annual evaluation of graduate students conducted by their major advisor includes an assessment of the student’s knowledge in their research area, laboratory proficiency, ability to communicate research results and findings, and overall progress towards completion of their degree.

17. **The Department should continue to conduct surveys of recent graduates, as this provides valuable feedback.**
Progress since review: Surveys of recent graduates and alumni will continue to be performed on a frequent basis. A new development is that exit interviews are being conducted by the department head with graduate students as they leave the program. This has been incorporated as a standard practice as part of the Department’s new Graduate Assessment Plan. During the interview, the students will be given opportunity to describe their experiences – good and bad – with the program as well as suggestions for improvements. Student feedback will be used to inform program improvements.

18. The Department is encouraged to develop a space and equipment utilization plan. Certainly Wiegand Hall is an older building, but attention should be placed on replacing old equipment and obtaining new equipment, such as autoclaves, cold storage units, freezers, and centrifuges.

Progress since review: The department has developed a detailed space plan in conjunction with University Facilities Services, which denotes the utilization of research laboratory, teaching laboratories, pilot plant and classroom space in Wiegand Hall. Priority space renovation and remodeling plans for Wiegand Hall are currently being prepared in conjunction with a request for coordinated fundraising activities by the College of Agricultural Sciences. Food Science and Animal & Rangeland Science are the two lead departments for this activity. The large bank of eight walk-in coolers and freezers in Wiegand Hall were replaced since the previous review at a cost of $500,000. These facilities support the graduate research programs in Food Science.

Space utilization plans for the Pilot Creamery and dairy and enology laboratories have also been prepared for those department-related activities which are conducted in space in Withycombe Hall. A major remodeling of the Pilot Creamery and adjacent laboratory space was recently completed.

19. An area of concern for graduate students involves the lack of a graduate student lounge. As part of the space utilization plan, the Department should consider creating a graduate student lounge separate from the undergraduate student lounge.

Progress since review: The Department has considered creating a separate graduate student lounge, however there is presently no available space in Wiegand Hall. Additional feedback is there is a strong working relationship between undergraduate students and graduate students in the Department, and this may create additional boundaries which are not currently present. Both our graduate and undergraduate students have common professional interests and participate in Food Science Club activities, and with the Student Association of the Institute of Food Technologists. There is not the typical age/maturity difference observed in other majors between graduate and undergraduate students, since many of our undergraduate students are transfer students and upperclassmen. Undergraduate students typically take core sciences classes their first two years outside of the department.
APPENDIX

I. Graduate Coursework Student Learning Outcomes

The majority of Food Science & Technology graduate coursework is provided via "slash" courses, that is, courses that are directed to both senior level undergraduate and graduate students. The learning outcomes are differentiated for each.

Core Curriculum Required Courses

MB 440/540 – Food Microbiology
1. Retain specialized language relevant to food microbiology.
2. Demonstrate basic knowledge about food microbiology and food-borne pathogenic microorganisms in general and detailed understanding of important aspects of the role in human disease and food contaminations.
3. Demonstrate understanding of research methods that permits them to read articles from current journals and extract pertinent information and judge the quality of the work described.
4. Retain key concepts relevant to food microbiology and food-borne microbial pathogens.

Additional learning outcomes for graduate students taking FST 540:
5. In addition to the previously described learning outcomes, graduate students will communicate scientific concepts and analytical arguments clearly and concisely, both orally and in writing.

BEE 472/572 – Introduction to Food Process Engineering
Upon completion of the course, students will be able to:
1. Analyze and solve Newtonian and non-Newtonian fluid flow problems.
2. Estimate the thermodynamic properties of process streams.
3. Perform material and energy balances around process units.
4. Calculate heat transfer coefficients of process streams.

Additional learning outcomes for graduate students taking FST 572:
5. Identify funding agency Request-for-Proposals of relevance to the course.
6. Synthesize a coherent proposal including budget.

Pick any two of the following five chemistry courses:

FST 422/522 – Food Chemistry Fundamentals
1. Students will be able to name and describe the chemical structures of the major components of foods (water, proteins, carbohydrates, and lipids) and selected minor components (e.g., pigments, additives, and/or flavor compounds).
2. Students will be able to give a molecular rationalization for the observed physical properties and reactivity of major food components.
3. Students will be able to provide a theoretical explanation for observed extents and rates of reactions that are common to foods.
4. Students will be able to predict how processing conditions are likely to change the reactivity of food components.
5. Students will be able to predict how changes in overall composition are likely to change the reactivity of individual food components.
6. Students will be able, through critical evaluation, to determine approaches that may be used to control the reactivity of those food components that are likely to impact the overall quality of finished products.

Additional learning outcomes for graduate students taking FST 522:
7. Students will be able to critically evaluate original research papers in food chemistry.
8. Students will be able to develop hypotheses, design experiments, and evaluate experimental data pertaining to chemistry-based food phenomena.
FST 423/523 – Food Analysis
1. Students will develop knowledge of representative techniques of macro- and micro-component food analysis. At the conclusion of the course students should be capable of:
   ♦ naming and describing the general principle of a range of methods available for common analytical problems including nutritional food labeling.
   ♦ describing in detail the basis and application of methods practiced in laboratory.
   ♦ demonstrating laboratory proficiency in the application of traditional methods of analysis.
   ♦ exercising judgment in the selection of a suitable method for specific analytical situations - taking into account sample preparation, necessary analytical equipment/instrumentation, required detection limit, sensitivity and interferences.
2. Students will increase their skills in reading and writing technical papers. The ability to analyze and interpret food analytical data will be demonstrated through a series of laboratory reports throughout the term.
Additional learning outcomes for graduate students taking FST 523:
3. Designing experiments (or an experiment) to solve practical concerns related to foods and agricultural products

FST 425/525 – Food Systems Chemistry
1. Students will be able to give molecular-level explanations for observed phenomena related to the major components of foods and beverages: as raw materials, and as they change during processing, storage. Or consumption.
2. Students will be able to predict how processing conditions are likely to change the physical and chemical characteristics of food components.
3. Students will be able to predict how changes in food formulations, raw material composition, or processing conditions are likely to change the characteristics of foods and their components.
4. Students will be able, through critical evaluation, to determine approaches that may be used to control the properties (e.g., color, texture, storage stability) of selected foods.
5. Students will be able to effectively summarize in writing scientific literature addressing complex food systems.
6. Students will be able to constructively critique the writing of peers, and to accept and incorporate feedback in their own writing.
Additional learning outcomes for graduate students taking FST 525:
7. Students will be able to develop hypotheses, design experiments, and evaluate experimental data pertaining to complex food phenomena.
8. Students will be able to critically evaluate original research papers in food chemistry.

FST 628 – Flavor Chemistry
1. Describe the general principles of a range of methods available for flavor isolation and analysis.
2. Exercise judgment in the selection of a suitable methods for flavor isolation and analysis based on the analytical objectives and sample matrix.
3. Describe the principles of flavor interactions with other food components
4. Name the most important aroma compounds in dairy, fruits and wines and describing their contributions to the aroma characteristics.

FST 641 - Processing Wheat and Other Small Grains: A Molecular View
1. Describe the path of wheat, and other small grains, from harvest, through milling and baking or other processing, to storage and consumption.
2. Describe the scientific and technological foundation required of a cereal product researcher or a skilled technical or artisan baker.
3. Describe and discuss:
   ○ grain structure and anatomy
   ○ the genetics of wheat grain texture
   ○ the relationship of wheat grain texture to grain fracture mechanics,
the basics of dough rheology and the physical chemistry of dough strength and stress relaxation, and the relationship of these phenomena to the craft of bread-making.

- the influence of selected enzyme technologies on cereal processing, storage, and consumption
- the influence of starch in bread-making

4. Synthesize the preceding into a coherent whole to be able to compare how differences in raw materials, ingredients, or process affect both intermediate processes and final outcomes.

5. Describe the chemical and physical phenomenology of the process of bread-making, including ingredient effects, pre-ferments, dough mixing, bulk dough fermentation, the importance of dough resting, dough shaping, proofing, the inter-relationships of mixing, bulk fermentation, and proofing times, and the transformation of dough to bread in the oven.

6. Identify raw material composition required to produce specified end-products.

7. Demonstrate an understanding of selected structure-function relationships of polymers and their relevance in selected cereal processing and storage operations.

8. Read and understand scientific literature relevant to the science of milling and baking and demonstrate ability to coherently summarize their findings orally and in writing.

**FST 607 Seminar** *(Students are required to register for two terms):*

1. Winter term: Students will learn methods and approaches for giving effective seminars
2. Spring term: Each PhD student will present a 50-min departmental seminar, on a topic chosen in consultation with their thesis advisor

**FST 609 Teaching Practicum** *(Students are required to register for four credits):*

Students must be able to demonstrate ability to present labs/lectures, work with individuals in groups or in laboratory, participate in designing specific lab exercises, grading lab reports and/or quizzes, and participating in lab preparation and/or clean-up.

**Elective Courses**

**FST 420/520 – Sensory Evaluation of Food**

1. To understand principles of physiology, psychology and measurement upon which methods of sensory testing are based.
2. To gain factual knowledge in sensory evaluation techniques.
3. To apply statistical knowledge in analyzing sensory data.
4. To apply their knowledge to real-world problems in the food and/or consumer product industry and food research.
5. To be able to design and execute a sensory study independently and to effectively communicate the results

Additional learning outcomes for graduate students taking FST 520:

6. Graduate students will conduct a final project related to his or her thesis work. Each student will individually consult with the course instructor about the project before undertaking.

**FST 421/521 – Food Law**

1. Students will be able to recall major food safety and food labeling laws and regulations and be able to explain their implications.
2. Students will understand and be able to explain the scientific bases of representative food laws and regulations.
3. Students will have a working familiarity with administrative law (rulemaking, enforcement tools, grievance channels, etc.)
4. Students will have the ability to access and work with statutes, regulations, and cases related to food law.
5. Students will be able to recognize and apply the basic analytical thought processes used in legal reasoning.
Additional learning outcomes for graduate students taking FST 521:
6. Students will be able to recognize and explain the government’s application of risk analysis in the regulatory management of food safety.
7. Students will be able to use the federal government’s evidence-based review system for drawing conclusions as to the validity of food-related health claims.

FST 460/560 – Brewing Science
1. articulate the technological processes and sequences required to malt grain, produce wort and ferment & finish beer
2. identify raw material composition and processing regimes required to produce a desired product
3. design a beer that meets generally acceptable standards
4. troubleshoot production practices when defects appear

Additional learning outcomes for graduate students taking FST 560:
5. identify and analyze 5-10 studies on a topic relevant to course content
6. synthesize a coherent written critique of those studies

FST 461/561 – Brewing Analysis
1. perform analytical measurements on raw materials and finished products for the purpose of assessing their quality
2. interpret analytical data from quality measurements for material specification sheets for the purpose of assessing their quality
3. identify and describe aromatic and flavor impacts and defects in commercial beer
4. This is a Writing Intensive Course (WIC) and has the following additional learning outcomes related to written communication in Fermentation Science:
   a. develop a written processing and testing regime for producing a specified beer style
   b. maintain a comprehensive record of laboratory work in a notebook
   c. write a concise report of the development and analysis of a trial of different brewing variables
   d. critique scientific writing and incorporate peer and instructor feedback into revisions of their own writing

Additional learning outcomes for graduate students taking FST 561:
5. research a technical brewing problem, analytical method or beer style
6. lecture undergraduate students on this topic
7. develop a laboratory exercise on this topic
8. write a technical report in journal manuscript form

FST 466 – Wine Production Principles
1. Understand, apply, and analyze the principles of wine production, encompassing the varietal and stylistic variations commonly encountered in modern wine production facilities.
2. Be knowledgeable in the biochemistry, chemistry and microbiology of all aspects of wine production, including stages from berry development through fermentation, bottling and aging. Be able to apply this knowledge if employed in a commercial wine operation.

FST 467/567 – Wine Production, Analysis, and Sensory Evaluation
1. All students will be able to:
   a. Produce red and white wine
   b. Understand the principles of wine sensory evaluation
   c. Have the ability to identify and name wine aromas and wine defects
   d. Determine the chemical and microbial condition of musts and wines
   e. Describe the influence of various wine production practices on the chemical and sensory composition of wines

Additional learning outcomes for graduate students taking FST 567:

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2. Design and undertake an additional project in the area of wine chemistry, microbiology, or sensory that utilizes and expands on material presented in class.

3. Critically evaluate two assigned scientific articles in the following way:
   a. Critically evaluate the claims made in the two papers by first determining what the claims were
   b. Identifying the specific experiments that provide the data used as evidence to support those claims
   c. Evaluate the evidence for each claim and discuss validity of the claims given the evidence

FST 479/579 – Fermentation Microbiology
1. Be able to correlate defects or alterations in microbial metabolism with overproduction of metabolites used as food ingredients.
2. With respect to specific fermented foods and beverages, be able to rationalize how and why the process of fermentation results in major changes to raw agricultural products.

Additional learning outcomes for graduate students taking FST 579:
1. Be able to write a critical evaluation of the claims of an assigned scientific article.
2. Teach class about a fermented food or beverage or food ingredient not covered by instructor in a 15-min oral presentation given in groups of 2 or 3 students.

FST 490/590 – Food Processing Calculations
7. Explain in technical and lay terms the fundamental principles of thermal processing, freezing, drying, intermediate moisture technology and high pressure processing.
8. Explain in technical and lay terms how these technologies depend on engineering properties that are intrinsic to foods (e.g., thermal conductivity, thermal diffusivity, moisture monolayer values, pH, a_w, etc.) and operational parameters (e.g., retort temperature, processing time, etc.) to produce foods that are safe, profitable and meet the quality expectations of the consumer.
9. Communicate effectively to other processors, consumers and regulatory officers the benefits and limits of each food processing technology covered in this course.
10. Use quantitative predictive models in process and product development supported by Excel spreadsheets for each food processing technology covered in this course.
11. Use critical thinking to identify solutions to product safety and quality problems.

Additional learning outcomes for graduate students taking FST 590:
12. Prepare a mini-lecture on a topic not covered in class.
13. Prepare a written critical review on a topic not covered in class.

FST 491/591 – Food Processing Calculations Laboratory
1. Identify key pieces of equipment for food processing and the utilities (steam, processing water, compressed air, etc.), and the temperature and flow control devices required for their operation.
2. Explain in technical and lay terms the operational principles of food processing.
3. Communicate to consumers and regulatory officers the benefits and limits of processing technologies.
4. Use Excel spreadsheets to implement quantitative predictive models in process and product development.
5. Use critical thinking and Excel spreadsheets to identify solutions to product safety and quality problems.

Additional learning outcomes for graduate students taking FST 591:
6. Design, execute and analyze experiments to validate a process using engineering models.
7. Synthesize predictive model calculations and experimental validation data into an oral group presentation.

FST 495/595 – Food Packaging
1. Identify current and future raw materials for use in food packaging
2. Identify major conversion technologies transforming a raw material into a packaging solution
3. Explain in technical and lay terms the differences of the conversion technologies so as to be able to make recommendations for the selection of a technology for a given product
4. Assess the impact of the key properties on the functional properties for each raw material used for packaging (e.g., impact of the fiber length on the mechanical properties of paper, effect of hydrophobic/hydrophilic nature of polymers on the moisture and gas permeability of plastic films)
5. Use critical thinking to identify packaging solutions to product safety and quality problems that are also attractive to consumers
6. Communicate effectively to consumers and regulatory officers the benefits and limits of packaging technologies with a particular emphasis on safety and environmental impact
7. Understand the role of packaging as the communication interface between producers and consumers

FST 511/NFM 511 - Health Benefits of Functional Foods, Nutraceuticals and Dietary Supplements
1. The student will be able to recognize the structures of the major bioactive food constituents that are being incorporated into functional foods. Know their sources, solubility properties, stabilities, and how they are absorbed and metabolized.
2. The student will be able to critically evaluate the trade literature as to the scientific validity of marketing claims.
3. The student will be able to recognize functional food products that are nutritionally logical, technically feasible, and that also are in compliance with FDA regulatory guidelines.
4. The student will be able to understand the differences between a dietary supplement and a functional food/nutraceutical, and the labeling/marketing around these substances.
5. The student will be able to become aware of specific research areas within functional foods, nutraceuticals, and dietary supplements
## II. Food Science Graduate Seminar Schedule – Spring 2011

<table>
<thead>
<tr>
<th>Wk</th>
<th>Date</th>
<th>Title</th>
<th>Speaker</th>
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<tbody>
<tr>
<td>1</td>
<td>Mar 29</td>
<td>INTRODUCTION</td>
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<tr>
<td>2</td>
<td>Apr 5</td>
<td>The Effects of Ethanol on the Absorption of Volatile Sulfur Compounds in Wine on SPME Fiber</td>
<td>Peter Davis</td>
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<tr>
<td>3</td>
<td>Apr 12</td>
<td>NO SEMINAR</td>
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<tr>
<td>4</td>
<td>Apr 19</td>
<td>Traceability for Specialty Crops / Methods for Reducing <em>Vibrio vulnificus</em> in Raw Oysters and Seafood Safety</td>
<td>Lisa Weller/ Jing Mou</td>
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<tr>
<td>5</td>
<td>Apr 26</td>
<td>Fluid Milk Shelf Life in Oregon: An Overview of Fluid Milk Quality</td>
<td>Liam Wustenberg</td>
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<tr>
<td>6</td>
<td>May 3</td>
<td>Characteristics of Deacetylation and Depolymerization of β-chitin from Jumbo Squid (<em>Dosidicus gigas</em>) Pens</td>
<td>Joo-Yeoun Jung</td>
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<tr>
<td>7</td>
<td>May 10</td>
<td>Analysis of Hop-derived Terpenes Using Headspace SPME and GC/FID</td>
<td>Peter Wolfe</td>
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<tr>
<td>8</td>
<td>May 17</td>
<td>The Impact of Malolactic Fermentation on Red Wine Color and Color Stability</td>
<td>Tresider Burns</td>
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<tr>
<td>9</td>
<td>May 24</td>
<td>The impact of taste and retronasal odor on vegetable liking</td>
<td>Arthi Padmanabhan</td>
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<tr>
<td>10</td>
<td>May 31</td>
<td>Effect of Alkaline Processing on Lignocellulosic Reactivity</td>
<td>Supaporn Sophonputtanaphoca</td>
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