

UNIVERSITY FACULTY SENATE FORMS

Academic Program Approval Requesting Permanent Status of the Food Science Major

This form is a routing document for the approval of new and revised academic programs. Proposing department should complete this form. For more information, call the Faculty Senate Office at 831-2921.

Submitted by: Kali Kniel **phone number:** 302-831-6513

Department: Animal and Food Sciences **email address:** kniel@udel.edu

Action: Permanent Status Program Review

(Example: add major/minor/concentration, delete major/minor/concentration, revise major/minor/concentration, academic unit name change, request for permanent status, policy change, etc.)

Effective term 14F

Current degree BS

Proposed change leads to the degree of: BS

Proposed name: Food Science (Please note no change)

List new courses required for the new or revised curriculum. How do they support the overall program objectives of the major/minor/concentrations)?

(Be aware that approval of the curriculum is dependent upon these courses successfully passing through the Course Challenge list. If there are no new courses enter "None")

No new courses are being proposed at this time.

Explain, when appropriate, how this new/revised curriculum supports the 10 goals of undergraduate education: <http://www.ugs.udel.edu/gened/>

The curriculum is not being revised at this time.

Identify other units affected by the proposed changes:

(Attach permission from the affected units. If no other unit is affected, enter "None")

None

Describe the rationale for the proposed program change(s):

(Explain your reasons for creating, revising, or deleting the curriculum or program.)

Permanent Status requested for this program.

Program Requirements:

(Show the new or revised curriculum as it should appear in the Course Catalog. If this is a revision, be sure to indicate the changes being made to the current curriculum and **include a side-by-side comparison** of the credit distribution before and after the proposed change.)

No new changes proposed, please see the senior checkout sheet and information contained within the next several pages. The program has been in existence at UD for many years (>40), but had a name change in 2008 where concentrations were removed from the major.

ROUTING AND AUTHORIZATION: (Please do not remove supporting documentation.)

Department Chairperson _____ Date _____

Dean of College _____ Date _____

Chairperson, College Curriculum Committee _____ Date _____

Chairperson, Senate Com. on UG or GR Studies _____ Date _____

Chairperson, Senate Coordinating Com. _____ Date _____

Secretary, Faculty Senate _____ Date _____

Date of Senate Resolution _____ Date to be Effective _____

Registrar _____ Program Code _____ Date _____

Vice Provost for Academic Affairs & International Programs _____ Date _____

Provost _____ Date _____

Board of Trustee Notification _____ Date _____

Revised 10/23/2007 /khs

Permanent Status Program Review (PSPR) Self Study

1. General Information about the program:

The Food Science Major is one of the three majors in the Department of Animal and Food Sciences. The Department of Animal and Food Science is committed to provide education, service and leadership for regional, national and international stakeholders through development, integration and dissemination of knowledge of animals used for food, fiber, companion, and recreational purposes; and for safe, responsible, ecologically sustainable, and competitive food production. Students within this major will participate in an academically challenging career by participating in courses which support the ten general education goals of the University of Delaware in various ways. Within the department the learning goals of the Department for all three majors are:

- Students will demonstrate oral communication skills important for communicating scientific ideas. (Communications Goal)
- Students will demonstrate written communication skills important for communicating scientific ideas. (Communications Goal)
- Students will use critical thinking and reasoning, skeptical inquiry and scientific approach to solve problems. (Critical Thinking Goal)
- Students will demonstrate knowledge of the major core concepts in the animal and food sciences. (Content Goal)

Within the Department of Animal and Food Sciences, students each receive faculty advisors and advisement is a critical element. Students are encouraged to meet with their advisors at a minimum of each semester. Advisors work closely with students to ensure students are on the correct academic pathway and are participating in internships and other elements of career enhancement during their academic undergraduate career.

Please note that the Food Science major has been in existence for more than 30 years; however, in 2008 concentrations were removed from the major of Food Science and Technology (with concentrations in Food Science or in Food Technology) and the major was given a new name of Food Science. There were extreme revisions made to the major at that time. For the most part the curriculum is today as it was before this change in 2008, and as noted below, courses are continuously updated with current content.

Food Science employs scientific principles in the design of new food products and explores ways to process, package and preserve the thousands of food items we consume to ensure their safety and quality. In the Food Science major, students initially obtain a broad background in the sciences (chemistry, biology, physics and math) as a basis for in-depth studies of the food science disciplines of food chemistry, food processing, food engineering, food safety, food microbiology, and food product development. Electives provide the opportunity for course work in areas ranging from business to molecular biology and allow students to obtain specialized knowledge in other fields important to Food Science, depending on their own interests. Graduates of the major will acquire the skills and knowledge for a successful and well paid career in all sectors of society concerned with the development and production of safe and healthy food. Sustainable

food production is key to the US and its role in the global economy. The major also lays the foundation for students who want to pursue an advanced degree in Food Science.

One of the strengths of the Food Science program is the connection between students and faculty. Not only do students and faculty interact in class and in laboratories, but they work together on research projects, in club activities, and through independent studies. Faculty serve as academic advisors, assisting with course selection, providing internship advice, and helping with career planning. Students who demonstrate strong academic performance and who wish to get practical research experience may choose to participate in the Science & Engineering Scholars program or pursue a Degree with Distinction under the supervision of a faculty mentor. The Food Science program emphasizes the acquisition of practical experience. For example, all upper level food science courses include a laboratory component; all faculty encourage and offer undergraduate research opportunities; and established links with regional food companies and government research facilities provide access to valuable internship experiences. In the Food Science Capstone course (ANFS 411), students conduct a semester-long project that includes the development of a novel food product, starting from basic ingredients and ending with the finished product. Along the way, the students conduct such tasks as taste testing, marketing research and quality control. Many Food Science majors enhance their undergraduate experience by joining the Food Science Club, which sponsors social and professional-development activities and serves as a student chapter of the Institute of Food Technologists (IFT). Students have the opportunity to meet, learn from, and network with professional food scientists at the monthly meetings of the Philadelphia Chapter of the IFT. The Club also fosters interaction with Food Science students from other universities through participation in the Food Science College Bowl and by sponsoring trips to the annual national meeting of the IFT

The College of Agriculture and Natural Resources houses the Food Science major, and its facilities are readily accessible to our students. Townsend and Worrilow Halls house our classrooms, faculty offices, and our food-science laboratories with equipment related to food processing, food microbiology and packaging. A test kitchen and small pilot-scale processing area located in the Newton Building are equipped for preparation of food-grade items that are only limited by students' imagination. The UDairy Creamery is also onsite where students can invent new flavors, and perform sensory and market analysis. This delicious new addition to the CANR family is a great way for students to see and experience food development first hand. Students work with UDairy Creamery staff and interns in course work and in extracurricular activities. An agriculture library and computing site with access to E-mail and the Internet provide support services for class work and research projects. For the most part the Food Science courses within the ANFS department are taught by 5 faculty who have rich backgrounds in the different areas of Food Science. Since Food Science is an area that is consistently changing regarding new technology and consumer trends the information within the courses changes as well to meet the demands of the students. Technology used within the courses also reflects the faculty knowledge and skills, who have almost all participated in the Institute for Undergraduate Education at the University of Delaware.

Curriculum Specifics: Students who successfully complete a major in Food Science earn a BS degree in Food Science. The curriculum is quite competitive to others in the nation due to the

fact that it is accredited by the Institute of Food Technologists. Students often obtain minors in Chemistry, and other areas like languages, Agri-business Management, and others. The curriculum satisfies the University, College and departmental requirements. There are unique aspects of the curriculum including problem-based learning within the hands-on laboratory classes and a culminating Capstone course in the Spring of Senior year. The senior check-out sheet for current students majoring in Food Science is found on the following two pages.

Food Science

Graduation Check Sheet

124 credits required

Fall 2013

Name:	UDID:	Phone:
Catalog Date:	Minor(s):	Email:

UNIVERSITY REQUIREMENTS

All requirements must be fulfilled as indicated in the University Catalog. Exceptions are granted only in extenuating circumstances and only by the Office of Academic Programs.

(7 credits)

COURSE	TITLE	CR	GRADE
ENGL 110	Critical Reading and Writing (minimum C-)	3	
ANFS 165 or UNIV 101	First Year Experience/FYE	1	
(ANFS 411)	Discovery Learning Experience (DLE)	*	
	Multicultural Course	3	

University Breadth Requirements⁰ (9 credits)
 (A minimum grade of C- is required for all University Breadths)

Creative Arts and Humanities			
		3	
History and Cultural Change			
		3	
Social and Behavioral Sciences			
		3	
Mathematics, Natural Sciences, and Technology			
(CHEM 103 already fulfills this requirement)		*	

COLLEGE BREADTH REQUIREMENTS

Agriculture and Natural Resources⁰
 (3 approved areas, 6 credits)

FREC 408 or STAT 200	Research Methods or Basic Statistical Practice	*	

Physical Sciences

(CHEM 103)	*	
(CHEM 104)	*	

MAJOR REQUIREMENTS

A minimum grade of C- is required for all courses with the ANFS rubric/subject area code. (91 credits)

COURSE	TITLE	CR	GRADE
BISC 207	Intro Biology I	4	
BISC 208	Intro Biology II	4	
BISC 300	Introduction to Microbiology	4	
CHEM 103	General Chemistry I	4	
CHEM 104	General Chemistry II	4	
CHEM 214	Elementary Biochemistry	3	
CHEM 220	Quantitative Analysis I	3	
CHEM 221	Quantitative Analysis Laboratory	1	
CHEM 321	Organic Chemistry I	4	
CHEM 322	Organic Chemistry II	4	
PHYS 201	General Physics I	4	
PHYS 202	General Physics II	4	
MATH 221	Calculus I	3	
NTDT 200	Nutrition Concepts	3	
APEC 408 or STAT 200	Research Methods or Basic Statistical Practice	3	
ANFS 102	Food for Thought	3	
ANFS 111	Animal and Food Science Laboratory	1	
ANFS 159	Topics in Food Science	1	
ANFS 230	Foodborne Diseases	3	
ANFS 305	Food Science	3	
ANFS 409	Food Processing	4	
ANFS 411	Food Science Capstone (DLE)	4	
ANFS 428	Food Chemistry	4	
ANFS 429	Food Analysis	4	
ANFS 439	Food Microbiology	4	
ANFS 443	Food Engineering	4	
ANFS 449	Food Biotechnology	4	

*Credits for these courses should not be counted in the total number of credit hours as they have already been included elsewhere on this checksheet.

MAJOR REQUIREMENTS CONT.

Second Approved Writing Requirement

A minimum grade of C- is required.

(3 credits)

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ELECTIVES

See catalog for restrictions.

COURSE	TITLE	CR	GRADE

Comments:

Use this space to provide information on course substitutions or waivers. All changes to Departmental/Major requirements must be approved in writing by the Department Chair. All changes to University/College requirements require approval of the Assistant Dean for Student Services.

Minimum Credit Hours Required for Graduation = 124

Your Total Credit Hours: _____

Major requirements are approved by your advisor and the department chair or designee:

Advisor's Signature: _____

Department Designee: _____

Student Signature: _____

Signature of the Office of Academic Programs: _____

Food Science

NOTES:

RE: University Breadth Requirements

Students may not use a course that is cross-listed with a subject area that has already been used to satisfy a university breadth requirement. Students enrolled in a single major may not satisfy the breadth requirement with courses in the subject area of that major (e.g. chemistry majors may not use CHEM courses). Students who are enrolled in more than one major or degree are allowed to meet the University breadth requirement by taking approved breadth courses from within the subject areas of their majors.

RE: College Breadth Requirements

A minimum of nine credits from any three different subject area codes, outside the subject area codes of the student's major, offered by the Departments in the College of Agriculture and Natural Resources. The exceptions would be any course that states in the course description that it cannot be used to satisfy the College breadth requirements, special problems, research, internships, first year experience, seminars, and similar courses.

Other:

It is possible that courses taken to fulfill Major requirements also may be used to fulfill University or College requirements; check your catalog and with your advisor for restrictions. In the case that one course fulfills two requirements, be advised that the credits count only ONCE toward the overall total. For example, using HIST 103 to fulfill both the multicultural course and the History and Cultural Change breadth requirement may be allowed; however, only 3 credits are counted toward the degree total.

2. Student Information:

We have 100% placement of employment for our undergraduates. Faculty work closely with students to ensure placement within internships during their 4-year undergraduate career and especially prior to graduation. We are fortunate to work with Joyce Henderson in career services and continue to add company profiles and opportunities.

Upon graduation, job opportunities are vast and include positions within the food and allied industries, government, and independent research institutions. The role of the food scientist in such positions may involve product and process development, food safety, engineering, quality control and analysis, technical service and sales, with opportunities in regulatory agencies, education, and basic research. Qualified students from our program go on to pursue graduate degrees in food safety, food chemistry, process engineering, food microbiology, and molecular biology. We encourage all students to participate in job-search workshops and career days, to seek internships, to develop communication skills, and to learn to network with prospective employers. This, in addition to doing well academically, greatly enhances post-graduate opportunities. Nearly all students participate in an internship at one or more food industries during their undergraduate career. While the Food Science major is fairly small, there has been consistent growth in the number of applications and the program receives several internal transfers each semester. This program has been identified in the College Master Plan as one for continued growth. One limitation compared to other schools in our region is the lack of food processing equipment and food preparation areas; however, we are working toward gaining funds to be able to design such spaces for our students.

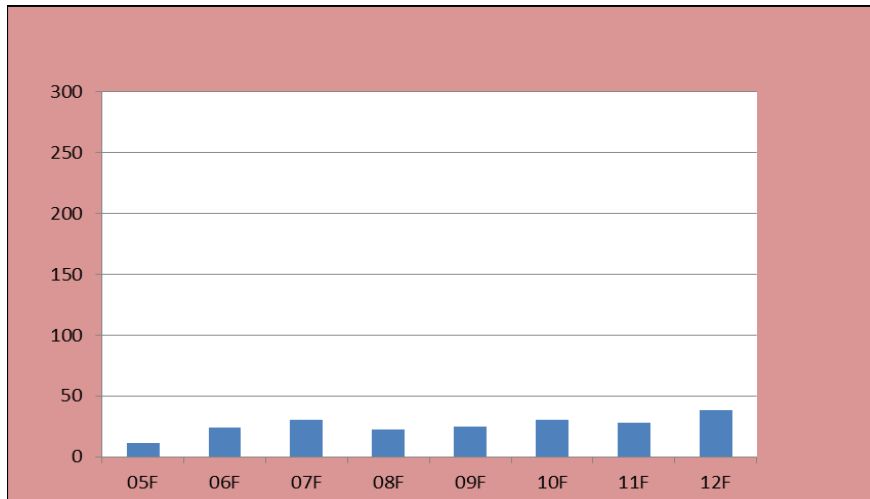
Students within the Food Science Program continue to be of high caliber (as noted in the Table below).

Fall Semester	No. Students ANFS/FS/Pre-Vet	ANFS			FS			Pre-Vet		
		SAT	HS GPA	HS %ile	SAT	HS GPA	HS %ile	SAT	HS GPA	HS %ile
08F	12/1/68	1732	3.64	78.1	2020	3.99	90	1844	3.58	82.5
09F	11/9/77	1705	3.52	82.3	1816	3.82	83	1809	3.64	85.2
10F	9/8/51	1759	3.60	91	1684	3.88	80.3	1818	3.75	89
11F	8/10/64	1759	3.54	84.8	1825	3.69	87.6	1774	3.65	86.1
12F	5/12/84	1610	3.49	74.3	1908	3.81	82.3	1814	3.71	86.4
Mean	7/8/69	1713	3.56	82.1	1851	3.84	84.6	1812	3.67	85.8

The Food Science program at the University of Delaware is a bit smaller than those in neighboring states; however, this likely in part reflects the state support of the Land-Grant University and specifically the space given to the Food Science program for processing food. We are currently working diligently with the UDairy Creamery and within the current infrastructure to better showcase sensory and produce development. Our students routinely state that our limited infrastructure does not limit their learning. (Please see the academic program review file for this statement by the review team as well). Our students favor the close relationship with faculty and our special niche in food safety education and opportunities for undergraduate research, in which many participate. Undergraduates obtain >2 internships with neighboring companies and also obtain undergraduate research, which combined with their coursework make

them more than well prepared for careers. Upon graduation, students often choose between 2 or more offers.

Enrollments in Food Science (Figure below) have grown consistently in recent years due to an aggressive recruitment effort on the part of ANFS and CANR staff and interest in the major on the part of students. In fact, freshman enrollment for the most recent semester, Fall 2013, is 15. We also receive 2-4 internal transfers each semester, and these numbers are not including n the graph below.



Additional information on enrollment, as requested is present in the Table below. This information was supplied from the registrars office, generated by Krista Urbaniak and Al Fanjoy.

FST - Food Science

Year	Applicants		Offer/Admit		Join Major as				Leave Major as		
	FR	TR	FR	TR	FR	TR	Change Major	Return to UD	Change Major	Leave UD	Complete Degree
2008-09	28	5	18	4	1	1	2		5	1	4
2009-10	46	4	25	1	9	1	1		1	1	4
2010-11	61	1	41	0	11	0	3		6	2	10
2011-12	45	8	33	5	9	2	1		2	4	0
2012-13	53	5	48	3	13	1	3		7	1	7
2013 Fall	59	2	53	2	14	1	1		?	?	?

Not final as of 1/9/2014

Appendices:

The Food Science major is accredited by the Institute of Food Technology and is evaluated every 5 years. We are currently undergoing this evaluation at this time and instituting program-wide assessment. Courses and faculty are assessed each year and changes made as appropriate. The current application for IFT re-approval of accreditation is found on the following pages. We anticipate re-approval and will hear on this in spring 2014.

Academic Program Review report from the recent review conducted in October 2013.

Letters of Support from Dr. Gelb (Department Chair) and Dr. Rieger (Dean of the College of Agriculture and Natural Resources).

INSTITUTE OF FOOD TECHNOLOGISTS
Application for Re-approval
of Undergraduate Degrees in Food Science

Submitted by

Food Science Program
Department of Animal & Food Sciences
University of Delaware

30 August 2013

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Application for 5-year Re-approval of Undergraduate Degrees in Food Science/Technology

Date of re-application submission 30 August 2013

Name of person completing this application Dallas G. Hoover, Ph.D.

Professional title	Professor
Mail address	Department of Animal & Food Sciences 531 South College Avenue, 044 Townsend Hall University of Delaware Newark, DE 19716-2150 USA
Email address	dgh@udel.edu
Office phone number	302/831-8772
Fax number	302/831-2822

Description of administrative unit

A.	Name of institution	University of Delaware
B.	Name of college	College of Agriculture & Natural Resources
C.	Name of department	Department of Animal & Food Sciences
D.	Name of department chair	Jack Gelb, Jr., Ph.D.
E.	All undergraduate degrees	B.S., Food Science B.S., Animal & Food Sciences B.S., Pre-Veterinary Medicine & Animal Biosciences
F.	To be evaluated for IFT approval	B.S., Food Science

Description of faculty

Food Science faculty members in the program

Name	Degree Undergraduate Institution	Appointment	Specialization	Courses taught
Chen, Haiqiang	Ph.D. Penn State	full-time member	Food process engineering	ANFS 409 ANFS 443

Hoover, Dallas G.	Ph.D. Minnesota	full-time member	Food microbiology	ANFS 159 ANFS 305 ANFS 439
Joerger, Rolf D.	Ph.D. North Carolina St.	full-time member	Food microbiology	ANFS 411 ANFS 449
Kniel, Kali E.	Ph.D. Virginia Tech	full-time member	Food microbiology	ANFS 102 ANFS 230
Sue O. Snider	Ph.D. Missouri	full-time member	Extension – Food safety	
Wu, Changqing	Ph.D. Clemson	full-time member	Food chemistry	ANFS 428 ANFS 429

Additional faculty

Name	Degree & institution	Appointment	Specialization	Courses assisted
M. Sharma	Ph.D. Georgia	affiliated	food safety/microbiology	ANFS 102 ANFS 230

Extenuating circumstances regarding faculty: None.

Description of facilities

Website describing and providing pictures of department facilities:

<http://ag.udel.edu/anfs/foodscience/food.html>

Teaching and research facilities used by the Food Science faculty are located in four buildings on the south campus of the University of Delaware and on the central campus (bus service available between Townsend/Worrilow Halls and central campus). There are five classrooms equipped with video and computer projection units located in Townsend Hall. Two of these classrooms are microcomputing/teaching facilities with approximately forty workstations. The conference room in the Allen Biotechnology Laboratory is used for seminars. Several classrooms located on the main campus of the University of Delaware are used for Food Science courses. Multimedia equipment is present in these classrooms. ITV facilities are located in the Allen Biotechnology Laboratory. The main library is located on the central campus. A room with approximately 20 computers for use by students is located in Townsend Hall. The computers offer access to the internet and programs such as Word and PowerPoint. The University offers help to students who require assistance with mathematics and writing

assignments. Students can also join study groups set up for individual classes. Counseling on how to deal with different academic or personal problems are also available through the University.

The primary Food Science teaching laboratory is located in Worrirow Hall. The facility provides laboratory bench space for approximately 25 students and is equipped with a chemical fume hood, two biological safety hoods, a refrigerator, incubators, water baths, stomacher, and equipment used for Food Microbiology, Food Analysis and Food Chemistry.

Analytical equipment for teaching and research purposes is available in labs in Worrirow Hall. The equipment includes a Pharmacia Biotech Ultrospec, a Hewlett Packard 5890 Gas Chromatograph with flame ionization detector, a Hewlett Packard 5890 Gas Chromatograph with flame ionization and electron capture detectors, a Perkin Elmer 1720 Fourier transform infrared spectrometer, a TA Instruments TGA 2950 HiRes Thermogravimetric Analyzer, an Ion Chromatograph with Waters pump and 430 Conductivity detector, a Gilson autosampler, a Molecular Devices Spectramax 190-plate reader, a Perkin Elmer 800 atomic absorption spectrophotometer, an ICP instrument for mineral analysis, and a carbon-nitrogen analyzer. Equipment for the Food Analysis and Food Chemistry laboratory courses is also located in 008 and 054 Townsend Hall (freeze-dryer, DSC, texture analyzer, spectrophotometer, Shimadzu Prominence HPLC system, BioTek Synergy 2 multi-mode microplate reader, colorimeter, refractometer, and viscometer). For the Food Microbiology laboratory course, a biosafety cabinet, chemical fume hood, various incubators and shakers are available in 014 Townsend. The laboratory section of the Food Biotechnology course makes use of equipment located in 053 Townsend Hall (electrophoresis units, PCR apparatus, gel documentation system, and electroporation unit). DNA-sequencing services for the Food Biotechnology laboratory course and for undergraduate research projects are located in the Allen Biotechnology Laboratory. Microscopy services are offered by the Delaware Biotechnology Institute and the Department of Biological Sciences.

A food-grade facility is located in the Newton Building. It houses a stove, refrigerators, a large sink, a food processor and all necessary utensils for preparation of food products. The Test Kitchen is used primarily for the Food Science Capstone course (ANFS 411) as a location to develop novel food products.

A food-grade pilot-scale processing facility is located in the basement of the Newton Building. It houses a large three-compartment sink, work tables, and various food-processing equipment. The equipment includes a freeze-dryer, homogenizer, pasteurizer, vertical bowl chopper, grinder, vacuum packager, and steam-jacketed kettles with and without attached mixers. The pilot plant is used primarily for product development for the Food Science Capstone and Food Processing courses. Additionally the Food Science Club utilizes the equipment for product sales. The facility is also used by other college faculty for the processing of honey sold in the UD Creamery.

Comparison of department facilities from previous application and current re-application.

Over the past five years we have had modest incremental improvements in equipment for undergraduate instruction; most of these improvements have been equipment purchased from individual research grants and then folded-in to support independent undergraduate research projects and procedures in class laboratory sections. Enrollments in upper-level undergraduate classes in food science traditionally have few students. Probably the most significant facilities addition from the previous application has been the UD Creamery. While the Creamery is a college facility and not a departmental one, by far its most important product for sale is ice cream, a value-added “food science product”. Students from the College run the Creamery, and several Food Science students have taken leadership roles, worked at facility and/or utilized the facility for projects in the Food Science Capstone course (ANFS 411). At the same time, the Creamery has been very successful in opening the eyes of the UD administration to the potential of successfully producing foods for promotion and sale. Therefore, interest, discussion, coursework and funds are gradually becoming available for ventures into larger-scaled projects in cheese-making, beer-making and manufacture of other value-added foods in our pilot plant in the Newton Building. Consequently our pilot plant is slowly receiving upgrades that we hope to increase in rate and number as a result of success and visibility of the UDairy Creamery. It can be described as “benefit by association”.

Description of curriculum

Specific website containing course descriptions for both background and departmental courses:
http://academiccatalog.udel.edu/Pub_ShowCatalogPage.aspx?CATKEY=CATKEY_562&ACYEAR=2013-2014&DSPL=Published

DEGREE: BACHELOR OF SCIENCE; MAJOR: FOOD SCIENCE

<i>CURRICULUM</i>		<i>CREDITS</i>
Math & Science Requirements		
BISC 207/BISC 208	Introductory Biology I and II	8
BISC 300	Introduction to Microbiology	4
CHEM 103/CHEM 104	General Chemistry	8
CHEM 214	Elementary Biochemistry	3
CHEM 220	Quantitative Analysis I	3
CHEM 221	Quantitative Analysis Laboratory	1
CHEM 321/CHEM 322	Organic Chemistry I and II	8
PHYS 201/PHYS 202	General Physics I and II	8
MATH 221	Calculus I	3
NTDT 200	Nutrition Concepts	3
APEC 408	Research Methods (or STAT 200)	3
UNIV 101	First-year experiences	1

MAJOR REQUIREMENTS

A minimum grade of C- is required for all ANFS credits used to satisfy the major requirements.

ANFS 102	Food for Thought	3
ANFS 111	Animal and Food Science Laboratory	1
ANFS 159	Topics in Food Science	1
ANFS 230	Foodborne Diseases	3
ANFS 265 ¹	Career Development	1
ANFS 305	Food Science	3
ANFS 428	Food Chemistry	4
ANFS 429	Food Analysis	4
ANFS 409	Food Processing	4
ANFS 411	Food Science Capstone (DLE)	4
ANFS 439	Food Microbiology	4
ANFS 443	Food Engineering	4
ANFS 449	Food Biotechnology	4

[Second Writing Requirement](#) (with a minimum grade of C-) 3**

A second writing course involving significant writing experience. The course must be taken after completion of 60 credit hours. Approved courses are designated each semester. (**These credits can be used to satisfy university breadth requirements.) (¹Strongly recommended but not required.)???

Suggested road map.

The UD Food Science Curriculum

Fall semester – Freshman year

ANFS 159 Topics in Food Science (1 cr)
UNIV 101 First-year Experience (1 cr)
NTDT 200 Nutrition Concepts (3 cr)
CHEM 103 General Chemistry I (4 cr)
MATH 221 Calculus I (3 cr)
ANFS 111 Animal Science Laboratory (1 cr)
Additional classes to total 12 to 17 credits

Fall semester - Sophomore Year

ANFS 230 Foodborne Diseases (3 cr)
CHEM 321 Organic Chemistry I (4 cr)
PHYS 201 Intro Physics I (4 cr)
Additional classes to total 12 to 17 credits

Fall semester - Junior Year

ANFS 428 Food Chemistry (even years) or
ANFS 409 Food Processing (4 cr)
BISC 208 Intro Biology II (4 cr)
CHEM 220 Quantitative Analysis (3 cr)
CHEM 221 Quantitative Analysis Lab (1 cr)
FREC 408 Statistics (3 cr Additional classes
to total 12 to 17 credits

Fall semester - Senior year

ANFS 428 Food Chemistry (4 cr, even years)
or ANFS 409 Food Processing (4 cr)
ANFS 439 Food Microbiology (4 cr)
¹Second Writing Requirement (3 cr)
Additional classes to total 12 to 17 credits

Spring semester – Freshman year

ENGL 110 Critical Reading & Writing (3 cr)
CHEM 104 General Chemistry II (4 cr)
ANFS 102 Food for Thought (3 cr)
Additional classes to total 12 to 17 credits

Spring semester - Sophomore year

BISC 207 Intro. Biology I (4 cr)
CHEM 322 Organic Chemistry II (4 cr)
ANFS 305 Food Science (3 cr)
PHYS 202 Intro Physics II (4 cr)
²ANFS 265 Career Development (1 cr)
Additional classes to total 12 to 17 credits

Spring semester - Junior Year

ANFS 429 Food Analysis (even years) or
ANFS 443 Food Engineering (4 cr)
BISC 300 Intro. Microbiology (4 cr)
CHEM 214 Elementary Biochemistry (3 cr)
¹Second Writing Requirement (3 cr)
Additional classes to total 12 to 17 credits

Spring semester - Senior year

ANFS 429 Food Analysis (even years) or
ANFS 443 Food Engineering (4 cr)
ANFS 449 Food Biotechnology (4 cr)
ANFS 411 Food Science Capstone (4 cr)
Additional classes to total 12 to 17 credits
¹Second Writing Requirement (3 cr)

¹A course that fulfills the University's
Second Writing Requirement is usually
taken in the junior or senior year.

²Strongly recommended but not required.

Changes to curriculum since 2008 have been minor. We have dropped the requirement for MATH 222, Calculus II and for CHEM 418, Physical Chemistry. We added UNIV 101, First-year Experience, ANFS 111, Animal & Food Sciences Laboratory, and ANFS 265, Career Development.

Program outcomes

Individual course outcomes

ANFS 102 Food For Thought (3 cr)

The course is an introductory course for Food Science, Animal Science and other majors interested in Food Science. At the end of the course the students are expected to be able to: Gain an appreciation for the complexity of the US food production, product development and distribution systems.

Develop a basic knowledge of contemporary issues affecting food production and distribution, consumer satisfaction, food quality, and food safety.

Develop skills necessary to understand food labels, and associated laws governing food production in the US.

Identify leaders in the food industry including regulatory agencies.

ANFS 159 Topics in Food Science (1 cr)

The course goal is for first-year undergraduate students to acquire a basic understanding of the area and scope of food science and technology. Students should come to appreciate the breadth and degree of detail of the diverse areas with regard to food production and commerce, food safety and security, and product development. The student should see how science and engineering contribute to our food manufacturing system. Additionally, the student will gain experience in group work (problem-based learning).

ANFS 230 Foodborne Diseases, Investigating Outbreaks (3 cr)

A successful participant in ANFS 230 should have the following skills upon completion of the course:

Have an understanding of the different players involved in outbreak investigation and be familiar with the epidemiology and trace-back techniques used to resolve an outbreak.

Have the skills to complete basic epidemiology calculations.

Be familiar with many of the microorganisms responsible for foodborne illnesses, including those that may threaten biosecurity.

Gain an increased awareness of outbreaks of foodborne illness and be able to critically evaluate the coverage of foodborne illness by popular media.

Gain writing, reading comprehension, and oral communication experience.

Develop critical thinking skills relevant to contemporary issues as opposed to acceptance of all issues.

ANFS 305 Food Science (3 cr)

The student should gain a fundamental understanding of food processing; an improved

understanding of the concepts of unit operations and how unit operations work on a large scale in food production and preservation resulting in processed food products. The disciplines of chemistry, microbiology and engineering will be reviewed and applied to foods and beverages. Completion of this course should allow students to better understand contemporary food controversies and problems related to foods.

ANFS 409 *Food Processing* (4 cr)

Upon completion of this course, students are expected to be able to:

Understand the principles and concepts of food processing and preservation.

Understand the major food processing and preservation technologies used in major food processing industries.

Understand the factors affecting product quality and shelf-life and know how to determine shelf life of food.

Understand the functions of packaging and the properties of metal, glass, paper, and plastic materials.

Be able to design a multi-layer packaging material for a specific foods based on the characteristics of the food.

Understand the concepts of blanching, pasteurization, sterilization, and ultra-high temperature (UHT) processing and know the equipment involved in these processes.

Understand the theories of refrigeration and freezing and the equipment involved.

Understand the theory of drying and equipment involved.

Understand the theory and application of modified atmosphere packaging.

Understand the concepts of antimicrobials and their uses in the food industry.

Understand basic principles of fermentation.

Understand the major membrane separation systems

Understand the major evaporation systems

Understand the basic principles of some new food processing technologies such as high pressure processing and irradiation.

Identify a research problem, write a research proposal, design and conduct experiments, analyze data and write a report in a journal format.

ANFS 411 *Food Science Capstone* (4 cr)

Utilizing knowledge and practical experience gained over the previous seven semesters, students will develop a novel food product. At the end of the course the students will have learned to:

Plan a project from conceptual stage to a final product.

Evaluate and refine recipes.

Interact with target groups (surveys, taste tests).

Interact with "mentors" (experts in the field).

Evaluate data from taste panels.

Write product development reports.

Apply or locate all necessary analytical techniques.

Make a food label.

Know about laws and regulations governing the developed food product.

Conceptualize an actual factory setting for the production of the developed food product (equipment and personnel, supply and waste management).

Arrive at cost estimates for the final product.

Develop a marketing strategy (including advertisement).

ANFS 428 *Food Chemistry* (4 cr)

The course is intended to give students an overview of the chemical and physical properties of the major and minor food components, and their changes during processing, handling and storage. The course will cover water, lipids, carbohydrates, protein, minerals, vitamins and enzymes in the context of the foods. In addition, color, flavor, texture, additives and regulatory control of food composition will be discussed. There will be an emphasis on the applied aspects of food chemistry with the help of real-world examples and laboratories. Some problem-based learning and group work will be integrated into the course. Moreover, oral or poster presentations, laboratory demonstrations, and tours will be used in the class. Laboratory reports, case studies, article critiques, presentations, quizzes, and exams including mid-term and final exams, will be used to assess the learning outcomes for students. At the end of the course, students will have:

Basic information on the food composition, and their chemical and physical characteristics during processing, storage, and handling.

Basic understanding on scientific basis for food formulation, quality control and regulation.

ANFS 429 *Food Analysis* (4 cr)

At the conclusion of the course, students should be:

Knowledgeable of food components of nutritional, functional, safety, and regulatory importance and their characteristics.

Knowledgeable of techniques available for the qualitative and quantitative analysis of food components and contaminants.

Able to choose appropriate analytical methods for the analyte and/or food system of interest in consideration of data required and resources available.

Able to interpret analytical data including use of common calculations.

Present analytical results, conclusions and implications in written and oral formats; and

Be aware of resources relevant to food analysis.

ANFS 439 *Food Microbiology* (4 cr)

The student will know the principles of microbiology as applied to foods as ecological systems. Students will gain a deeper knowledge of the microorganisms involved in food spoilage, foodborne disease and in the production of fermented foods and beverages. The student should appreciate how food products are developed and produced to ensure safety and an adequate shelf-life.

ANFS 443 *Food Engineering Technology* (4 cr)

Upon completion of this course, students are expected to be able to:

Understand the basic engineering fundamentals and principles for food processing.

Understand the basic principles of mass and energy balances and able to apply them in food processing.

Understand the basic concepts of rheology and measurement of viscosity.

Understand the different modes of heat transfer and thermophysical properties such as specific heat, thermal conductivity, thermal diffusivity, convective heat transfer coefficient and Biot number.

Understand the principle of thermal processing. Be able to calculate D, z, thermal death time and thermal lethality.

Understand principles of refrigeration. Be able to identify the major components of a refrigeration system and conduct refrigeration calculations.

Understand different freezing systems and predict freezing time.

Understand principles of psychrometrics.

Be able to read a psychrometric chart and conduct mathematical calculations on air-water vapor mixtures.

ANFS 449 Food Biotechnology (4 cr)

The students will learn about the following aspects of food biotechnology in order to understand the scope of food biotechnology and to be able to participate in contemporary discussions on the topic:

Production of foods and food ingredients through fermentation.

Production and role of enzymes used in food processing.

Use of genetically modified microorganisms for the production of food ingredients.

Fermentation equipment, media, purification of products, formulation and waste issues.

Plant Biotechnology: Techniques, and agricultural, economical, ethical, ecological issues.

Animal Biotechnology: Techniques, current status and ethical issues.

Reading primary literature on the various topics.

Program outcomes and assessments

Tools used to assess program outcomes were exit interviews or examinations, alumni surveys, employer surveys, and feedback from food industry individuals. Students' course evaluations are collected for each class. Ratings for each applicable questions or statement in the form are tabulated, and together with the students' written comments are distributed to the instructor and the department chair. The evaluations serve as a basis for improvement of individual courses.

The overall outcome of the curriculum is reflected in the ease of obtaining employment or graduate school acceptance for graduating students. In recent years, all graduating students have obtained employment or admission to graduate school within a short time of graduation. Among the companies that hired new graduates were Campbell's Soup Company World Headquarters, TIC Gums, McCormick Flavors, David Michael & Co., DuPont, SPI Polyols (now Bunge), and InB Biotechnologies, Inc. Students have been accepted to such graduate schools as Kansas State, University of Delaware, University of Maryland, Rutgers University and Cornell.

Summary of student assessments over the previous five-year period.

Assessment program reports follow on the next page.

Link to post-graduation survey: <http://ag.udel.edu/anfs/survey.html>

A. Rate the quality of education						
Question	Excellent	Good	Average	Poor	Responses	Mean
Basic food components & structures	3	3	-	-	6	1.50
Raw food properties	1	4	1	-	6	2.00
Chemistry changes in food during preparation and storage	2	4	-	-	6	1.67
Principles, methods, & techniques of qualitative and quantitative analysis	1	4	1	-	6	2.00
Food preservation principles	3	2	1	-	6	1.67
Control of microorganisms in food	3	3	-	-	6	1.50
Pathogenic & spoilage microorganisms	4	-	1	1	6	1.83
Beneficial microorganisms	3	1	1	1	6	2.00
Engineering principles	5	1	-	-	6	1.17
Food processing principles & techniques	5	1	-	-	6	1.17
Packaging, cleaning & sanitation	2	3	1	-	6	1.83
Water & waste management	-	2	2	2	6	3.00
Quality assurance	1	3	1	1	6	2.33
Assessing sensory properties of food	-	1	3	2	6	3.17
Food law and regulations	-	2	3	1	6	2.83
Oral communication skills	3	1	2	-	6	1.83
Written communication skills	4	1	1	-	6	1.50
Critical thinking/problem solving skills	4	2	-	-	6	1.33
Computer skills	3	2	1	-	6	1.67
Statistical skills	1	4	1	-	6	2.00
Professional ethics	3	2	1	-	6	1.67
Respect for diversity	3	2	1	-	6	1.67
Ability to cooperate with others in group projects	5	-	1	-	6	1.33
Ability to research topics independently	5	-	1	-	6	1.33

Results of Survey of Graduating Food Science Seniors – 2013

Comments for graduating seniors, 2013:

Please provide one recommendation to improve the program.

“Understand that most students are interested in product development/sensory and teach more about that.”

“A specific sensory class would be very helpful because we get a very small taste of it in our classes. A cooking class would be nice too so that we could apply technical knowledge with something more hands on. Capstone would be a much better experience if it was planned out over the course of a year. A semester is way too rushed. More importantly though, having an ounce of equipment available to use in labs such as weigh boats, clean beakers/flasks/test tubes, and some machines that aren't from the early 50s would be much appreciated by the students. It's hard to enjoy the lab experience when there is so little to work with. Many of the machines don't work well and adequate data comes few and far between.”

“Follow proper lab protocol.”

“More focus on sensory studies.”

Please list learning experiences that were particularly memorable or helpful to you.

“Ag Ambassadors”

“Working at the UDairy Creamery was a unique experience that allowed me to flex all of my Food Science knowledge as well as gain experience working in real life situations that were played out in class.”

“Some of the labs were interesting.”

“All classes taught by Dr. Chen were interesting and where I learned a great deal of knowledge. Also the strategic selling and buying communication class taught by Dr. T helped me not only to sell a product, but sell myself. The information I learned in that class was especially helpful when interviewing. The career development class taught by Dr. Kniel also was a great help because I learned to write a resume, cover letter, and market myself.”

“The foodborne diseases course really helped with landing my first internship.”

No data available for graduating food science seniors in 2012.

Results of Survey of Graduating Food Science Seniors – 2011

A. Rate the quality of education you received in particular areas

	Excellent	Good	Average	Poor	Responses	Mean
Basic food components & structures	6	1	2	0	9	1.56
Raw food properties	4	0	4	0	8	2.00
Chemistry changes in food during preparation and storage	3	5	1	0	9	1.78
Principles, methods, & techniques of qualitative and quantitative analysis	4	2	2	1	9	2.00
Food preservation principles	8	0	1	0	9	1.22
Control of microorganisms in food	6	3	0	0	9	1.33
Pathogenic & spoilage microorganisms	6	3	0	0	9	1.33
Beneficial microorganisms	4	5	0	0	9	1.56
Engineering principles	8	1	0	0	9	1.11
Food processing principles & techniques	7	2	0	0	9	1.22
Packaging, cleaning & sanitation	2	5	2	0	9	2.00
Water & waste management	1	0	3	5	9	3.33
Quality assurance	2	2	3	2	9	2.56
Assessing sensory properties of food	0	2	3	4	9	3.22
Food law and regulations	1	2	3	3	9	2.89
Oral communication skills	1	8	0	0	9	1.89
Written communication skills	4	3	2	0	9	1.78
Critical thinking/problem solving skills	4	3	2	0	9	1.78
Computer skills	4	1	3	1	9	2.11
Statistical skills	4	3	1	1	9	1.89
Professional ethics	4	2	2	1	9	2.00
Respect for diversity	4	4	1	0	9	1.67
Ability to cooperate with others in group projects	8	1	0	0	9	1.11
Ability to research topics independently	7	2	0	0	9	1.22

Results of Survey of Graduating Food Science Seniors – 2010

A. Rate the quality of education you received in particular areas

	Excellent	Good	Average	Poor	Responses	Mean
Basic food components & structures	3	0	0	0	3	1.00
Raw food properties	2	1	0	0	3	1.33
Chemistry changes in food during preparation and storage	3	0	0	0	3	1.00
Principles, methods, & techniques of qualitative and quantitative analysis	1	2	0	0	3	1.67
Food preservation principles	3	0	0	0	3	1.00
Control of microorganisms in food	2	0	1	0	3	1.67
Pathogenic & spoilage microorganisms	1	1	1	0	3	2.00
Beneficial microorganisms	0	2	1	0	3	2.33
Engineering principles	2	1	0	0	3	1.33
Food processing principles & techniques	2	1	0	0	3	1.33
Packaging, cleaning & sanitation	2	1	0	0	3	1.33
Water & waste management	0	2	1	0	3	2.33
Quality assurance	0	2	1	0	3	2.33
Assessing sensory properties of food	1	1	1	0	3	2.00
Food law and regulations	0	3	0	0	3	2.00
Oral communication skills	3	0	0	0	3	1.00
Written communication skills	2	1	0	0	3	1.33
Critical thinking/problem solving skills	1	2	0	0	3	1.67
Computer skills	2	1	0	0	3	1.33
Statistical skills	0	2	1	0	3	2.33
Professional ethics	2	1	0	0	3	1.33
Respect for diversity	2	1	0	0	3	1.33
Ability to cooperate with others in group projects	3	0	0	0	3	1.00
Ability to research topics independently	3	0	0	0	3	1.00

Results of Survey of Graduating Food Science Seniors – 2009

A. Rate the quality of education you received in particular areas

	Excellent	Good	Average	Poor	Responses	Mean
Basic food components & structures	3	3	0	0	6	1.50
Raw food properties	1	2	1	0	4	2.00
Chemistry changes in food during preparation and storage	4	1	0	0	5	1.20
Principles, methods, & techniques of qualitative and quantitative analysis	2	2	1	0	5	1.80
Food preservation principles	4	1	0	0	5	1.20
Control of microorganisms in food	5	0	0	0	5	1.00
Pathogenic & spoilage microorganisms	4	1	0	0	5	1.20
Beneficial microorganisms	0	4	1	0	5	2.20
Engineering principles	4	1	0	0	5	1.20
Food processing principles & techniques	5	0	0	0	5	1.00
Packaging, cleaning & sanitation	4	1	0	0	5	1.20
Water & waste management	0	3	1	1	5	2.60
Quality assurance	1	3	1	0	5	2.00
Assessing sensory properties of food	1	3	1	0	5	2.00
Food law and regulations	0	4	1	0	5	2.20
Oral communication skills	2	3	0	0	5	1.60
Written communication skills	2	3	0	0	5	1.60
Critical thinking/problem solving skills	3	2	0	0	5	1.40
Computer skills	2	3	0	0	5	1.60
Statistical skills	2	2	1	0	5	1.80
Professional ethics	3	0	2	0	5	1.80
Respect for diversity	4	1	0	0	5	1.20
Ability to cooperate with others in group projects	4	1	0	0	5	1.20
Ability to research topics independently	3	2	0	0	5	1.40

*Alumni survey conducted in 2013
of UD Food Science graduating classes of 2005 to 2011.*

Responses to the question: How useful has your education been to your current job?

Alumni, Year of graduation: 2005

	Excellent	Good	Average	Poor	Responses	Mean
Basic food components & structures	1	1	1		3	2.00
Raw food properties		1	2			2.67
Chemistry changes in food during preparation and storage			3		3	3.00
Principles, methods, & techniques of qualitative and quantitative analysis	1	1	1		3	2.00
Food preservation principles	1	2			3	1.67
Control of microorganisms in food	2	1			3	1.33
Pathogenic & spoilage microorganisms	1	2			3	1.67
Beneficial microorganisms	1	2				1.67
Engineering principles			2	1	3	3.33
Food processing principles & techniques			3		3	3.00
Packaging, cleaning & sanitation		1	1	1	3	3.00
Water & waste management				3	3	4.00
Quality assurance			3		3	3.00
Assessing sensory properties of food		1	2		3	2.67
Food law and regulations		1	2		3	2.67
Oral communication skills	1	1		1	3	2.33
Written communication skills	1	2			3	1.67
Critical thinking/problem solving skills	3				3	1.00
Computer skills	2	1			3	1.33
Statistical skills	2		1		3	1.67
Professional ethics	1	1	1		3	2.00
Respect for diversity	2		1		3	1.67
Ability to cooperate with others in group projects	3				3	1.00
Ability to research topics independently	3				3	1.00

No responses from food science students who graduated in 2006.

Alumni, Year of graduation: 2007

	Excellent	Good	Average	Poor	Responses	Mean
Basic food components & structures	1				1	1.00
Raw food properties		1			1	2.00
Chemistry changes in food during preparation and storage	1				1	1.00
Principles, methods, & techniques of qualitative and quantitative analysis			1		1	3.00
Food preservation principles	1				1	1.00
Control of microorganisms in food	1				1	1.00
Pathogenic & spoilage microorganisms	1				1	1.00
Beneficial microorganisms	1				1	1.00
Engineering principles	1				1	1.00
Food processing principles & techniques	1				1	1.00
Packaging, cleaning & sanitation	1				1	1.00
Water & waste management	1				1	1.00
Quality assurance	1				1	1.00
Assessing sensory properties of food	1				1	1.00
Food law and regulations	1				1	1.00
Oral communication skills	1				1	1.00
Written communication skills	1				1	1.00
Critical thinking/problem solving skills	1				1	1.00
Computer skills	1				1	1.00
Statistical skills	1				1	1.00
Professional ethics	1				1	1.00
Respect for diversity	1				1	1.00
Ability to cooperate with others in group projects	1				1	1.00
Ability to research topics independently	1				1	1.00

Alumni, Year of graduation: 2008

	Excellent	Good	Average	Poor	Responses	Mean
Basic food components & structures	2		1	1	4	2.25
Raw food properties		2	1	1	4	2.75
Chemistry changes in food during preparation and storage	2		1	1	4	2.25
Principles, methods, & techniques of qualitative and quantitative analysis	1	2	1		4	2.00
Food preservation principles	2		2		4	2.00
Control of microorganisms in food	2	2			4	1.50
Pathogenic & spoilage microorganisms	2	2			4	1.50
Beneficial microorganisms	2	1	1		4	1.75
Engineering principles	1	2	1		4	2.00
Food processing principles & techniques	1	2	1		4	2.00
Packaging, cleaning & sanitation		1	3		4	2.75
Water & waste management		1	1	2	4	3.25
Quality assurance	1	1	2		4	2.25
Assessing sensory properties of food	1		2	1	4	2.75
Food law and regulations	2		1	1	4	2.25
Oral communication skills	2	1	1		4	1.75
Written communication skills	1	2	1		4	2.00
Critical thinking/problem solving skills	2		2		4	2.00
Computer skills	2	1	1		4	1.75
Statistical skills	1	1	1	1	4	2.50
Professional ethics	2	1	1		4	1.75
Respect for diversity	2	1	1		4	1.75
Ability to cooperate with others in group projects	3		1		4	1.50
Ability to research topics independently	2	1	1		4	1.75

Alumni, Year of graduation: 2009

	Excellent	Good	Average	Poor	Responses	Mean
Basic food components & structures	1				1	1.00
Raw food properties	1				1	1.00
Chemistry changes in food during preparation and storage			1		1	3.00
Principles, methods, & techniques of qualitative and quantitative analysis		1			1	2.00
Food preservation principles					1	0.00
Control of microorganisms in food	1				1	1.00
Pathogenic & spoilage microorganisms	1				1	1.00
Beneficial microorganisms		1			1	2.00
Engineering principles	1				1	1.00
Food processing principles & techniques	1				1	1.00
Packaging, cleaning & sanitation	1				1	1.00
Water & waste management			1		1	3.00
Quality assurance			1		1	3.00
Assessing sensory properties of food	1				1	1.00
Food law and regulations		1			1	2.00
Oral communication skills	1				1	1.00
Written communication skills	1				1	1.00
Critical thinking/problem solving skills	1				1	1.00
Computer skills		1			1	2.00
Statistical skills			1		1	3.00
Professional ethics	1				1	1.00
Respect for diversity	1				1	1.00
Ability to cooperate with others in group projects	1				1	1.00
Ability to research topics independently	1				1	1.00

Alumni, Year of graduation: 2010

	Excellent	Good	Average	Poor	Responses	Mean
Basic food components & structures	2	1			3	1.33
Raw food properties	1	2			3	1.67
Chemistry changes in food during preparation and storage	1	2			3	1.67
Principles, methods, & techniques of qualitative and quantitative analysis	2	1			3	1.33
Food preservation principles	2	1			3	1.33
Control of microorganisms in food	2	1			3	1.33
Pathogenic & spoilage microorganisms	2	1			3	1.33
Beneficial microorganisms	1	1		1	3	2.33
Engineering principles					3	0.00
Food processing principles & techniques	2		1		3	1.67
Packaging, cleaning & sanitation	1	1	1		3	2.00
Water & waste management		1	1	1	3	3.00
Quality assurance		2	1		3	2.33
Assessing sensory properties of food	1	1	1		3	2.00
Food law and regulations		2	1		3	2.33
Oral communication skills	1	1	1		3	2.00
Written communication skills	1	2			3	1.67
Critical thinking/problem solving skills	2	1			3	1.33
Computer skills	1	2			3	1.67
Statistical skills		2	1		3	2.33
Professional ethics	1	1	1		3	2.00
Respect for diversity	1	1	1		3	2.00
Ability to cooperate with others in group projects	1	2			3	1.67
Ability to research topics independently	2	1			3	1.33

Alumni, Year of graduation: 2011

	Excellent	Good	Average	Poor	Responses	Mean
Basic food components & structures	3	4			7	1.57
Raw food properties	2	4	1		7	1.86
Chemistry changes in food during preparation and storage	4	2		1	7	1.71
Principles, methods, & techniques of qualitative and quantitative analysis	4	2	1		7	1.57
Food preservation principles	5	2			7	1.29
Control of microorganisms in food	6	1			7	1.14
Pathogenic & spoilage microorganisms	6	1			7	1.14
Beneficial microorganisms	2	4	1		7	1.86
Engineering principles	4	3			7	1.43
Food processing principles & techniques	6	1			7	1.14
Packaging, cleaning & sanitation	3	3	1		7	1.71
Water & waste management		2	4	1	7	2.86
Quality assurance	2	4	1		7	1.86
Assessing sensory properties of food		1	5	1	7	3.00
Food law and regulations		4	3		7	2.43
Oral communication skills	4	1	2		7	1.71
Written communication skills	2	3	2		7	2.00
Critical thinking/problem solving skills	5	1			7	1.00
Computer skills	3	3	1		7	1.71
Statistical skills	1	5	1		7	2.00
Professional ethics	3	1	3		7	2.00
Respect for diversity	4	1	2		7	1.71
Ability to cooperate with others in group projects	5	2			7	1.29
Ability to research topics independently	6	1			7	1.14

Combined data from alumni responses from classes of 2005 to 2012.

Please rate how you currently view the quality of education you received in the particular areas listed below.

		EXCELLENT	GOOD	AVERAGE	POOR
a.	Basic food components & structures	50%	35%	10%	5%
b.	Raw food properties	25%	50.0%	20%	5%
c.	Chemistry changes in food during preparation and storage	35%	30%	25%	10%
d.	Principles, methods, & techniques of qualitative and quantitative analysis	45%	40%	15%	0%
e.	Food preservation principles	55%	30%	15%	0%
f.	Control of microorganisms in food	70%	30%	0.0%	0%
g.	Pathogenic & spoilage microorganisms	70%	30%	0.0%	0%
h.	Beneficial microorganisms	40%	45%	10%	5%
i.	Engineering principles	45%	30%	20%	5%
j.	Food processing principles & techniques	55%	20%	25%	0%
k.	Packaging, cleaning & sanitation	30%	35%	30%	5%
l.	Water & waste management	5%	21%	37%	37%
m.	Quality assurance	20%	40%	40%	0%
n.	Assessing sensory properties of food	15%	20%	50.0%	15%
o.	Food law and regulations	10%	40%	45%	5%
p.	Oral communication skills	50%	25%	20%	5%
q.	Written communication skills	35%	45%	20%	0%
r.	Critical thinking/problem solving skills	70%	15%	15%	0%
s.	Computer skills	45%	40%	15%	0%
t.	Statistical skills	20%	40%	35%	5%
u.	Professional ethics	45%	20%	35%	0%
v.	Respect for diversity	70%	20%	10%	0%
w.	Ability to cooperate with others in group projects	70%	20%	10%	0%
x.	Ability to research topics independently	75%	15%	10%	0%

Please indicate how useful the learning experience is to your current job.

		VERY USEFUL	SOMEWHAT USEFUL	LESS USEFUL	NOT USEFUL AT ALL
a.	Basic food components & structures	60%	20%	10%	10%
b.	Raw food properties	50%	40%	10%	0%
c.	Chemistry changes in food during preparation and storage	70%	20%	10%	0%
d.	Principles, methods, & techniques of qualitative and quantitative analysis	50%	35%	15%	0%
e.	Food preservation principles	45%	45%	10%	0%
f.	Control of microorganisms in food	40%	40%	15%	5%
g.	Pathogenic & spoilage microorganisms	40%	40%	10%	10%
h.	Beneficial microorganisms	20%	35%	40%	5%
i.	Engineering principles	25%	45%	30%	0%
j.	Food processing principles & techniques	47%	37%	11%	5%
k.	Packaging, cleaning & sanitation	35%	40%	15%	10%
l.	Water & waste management	5%	15%	50%	30%
m.	Quality assurance	55%	30%	5%	10%
n.	Assessing sensory properties of food	65%	35%	0%	0%
o.	Food law and regulations	40%	40%	10%	10%
p.	Oral communication skills	75%	20%	5%	0%
q.	Written communication skills	75%	25%	0%	0%
r.	Critical thinking/problem solving skills	90%	10%	0%	0%
s.	Computer skills	80%	15%	5%	0%
t.	Statistical skills	55%	30%	15%	0%
u.	Professional ethics	80%	20%	0%	0%
v.	Respect for diversity	80%	15%	5%	0%
w.	Ability to cooperate with others in group projects	75%	20%	5%	0%
x.	Ability to research topics independently	70%	25%	5%	0%

Summary reflections

Are the curriculum, practices, processes, and resources properly aligned with the outcomes of the program?

The alignment of our undergraduate program is appropriate for our outcomes and goals. We have followed IFT guidelines for some time with regard to the structure of our curriculum and made adjustments to our curriculum in order to continually and consistently improve our teaching, advising and mentoring. It is recognized that we have areas that require our attention for improvement. These areas have been identified and solutions are being sought.

Are department/program goals aligned with the goals of the food industry and graduate programs that the program serves?

The food science program at the University of Delaware offers M.S. and Ph.D. degrees as well as the B.S. so compared to other food science programs and departments in the nation we have a relevant estimation of how our undergraduate program aligns with our own graduate program and therefore will align with others. We maintain an active presence in the IFT Philadelphia section and network there monthly during the school year. Our graduates return to give presentations and interact with our Food Science Club as well as present and discuss food science careers at our annual Food Exploration Day where we recruit interested high school students to become food science majors at the University of Delaware. These interactive mechanisms constantly provide us with feedback on our relevance and adequacy of educational standards for the food industry and food science graduate programs.

Is the level of program quality aligned with the college/university's acceptable level of program quality? Is the program quality aligned with the constituents' acceptable level of quality?

Yes. We have had no indication from our college or university administrations of any subpar performances on our part. Just the opposite, as our UDairy Creamery has been a public relations success for the university and college, our good standing has risen to the point we are hopeful the praise will eventually equate for hardware and facilities improvements to manufacture cheese, and potentially beer, in the future. We continually court dialog with local industry in order to locate partners who can help us meet our goals and help our students.

Are program goals being achieved?

Yes. The atmosphere is positive in the program. We are eager to witness a significant step forward for our program, whether a substantial contribution to our facilities, or the addition of another food science faculty line.

Are student-learning outcomes being achieved at the expected level?

Yes, from our exit surveys, we believe so. Yes, there is room for improvement, but we think we know our weaknesses and how we need to strengthen them. Increased enrollments help justify the needed resources in today's economy.

What guidelines will be used to determine what the evidence suggests about the program's strengths and weaknesses?

From what we have seen, the assessments we use identify strengths and weaknesses reasonably. We look forward to feedback from the IFT Higher Education Review Board with regards to their assessments since HERB has access to relevant information from other food science programs so that comparisons can be made and valuable recommendations suggested.

Future goals and planning for improvement

Future assessment strategies and goals, and how curricular improvements will be maintained:

We intend to maintain our IFT certification, so following IFT guidelines and guidance will assist greatly in maintaining quality of our teaching program. Our undergraduate enrollments are increasing and we are receiving accolades and promises of support from our college administration, so we plan to continue with the assessment mechanisms we currently have in place. We believe they are working. We will continue with our goal of slowly growing our program while maintaining 100% placement of our graduates. To help improve our teaching facilities, we are actively working with college administration and our industry network to expand our outreach and interactions with the food industry.

What are the program's assessment goals for the next five years?

We feel we have a quality program; we are proud of our graduates. As noted above, we plan to maintain our assessment mechanisms and use this valuable feedback to fine-tune our curriculum while slowly growing our enrollments. We now have 42 undergraduate students. While not a very large number compared to the larger food science programs in the country, for us it is the highest number we have ever had. In the 1990s, it was not uncommon to total <10 undergraduates in our program at any given time, but times have changed. In the spring of 2014 we will introduce a new undergraduate course, PLSC/ANFS 267 Fermentations: Brewing & Beyond. This is a joint course offered with the Department of Plant & Soil Sciences in our college to increase college undergraduate enrollments and also to strengthen ties with local Delaware craft breweries such as Dogfish Head Brewery and Twin Lakes Brewery. With continued expansion in our number of majors we can justify the need for another faculty line in the program. Student activities associated with product development will continue in the area of ice cream products at the UDairy Creamery and will likely increase as relationships with local snack food companies (Herr's Foods and Utz Quality Foods) develop.

How will the program specifically address any weaknesses identified in previous assessments?

Surveys have indicated a general satisfaction of graduating students and alumni students with their learning experiences at UD. Because we are a small program with a range over the past ten years of one to eleven graduating seniors, our response numbers are low. In some years we've had no responses even after pressing with email requests. We realize the low number of responses does statistically weaken these assessments.

Overall, student responses were positive, but they also indicated some areas that the program can improve. Some of these areas were noted in our last review; we are aware of the need to further improve these specific situations.

Sensory properties: Sensory analysis has been taught as part of the Food Analysis course (ANFS 429), is included within lessons of Food for Thought (ANFS 102) and Food Science (ANFS 305), and is an important part of the learning process in the Food Capstone course (ANFS 411). There is a sustained level of interest shown by our students for product development and sensory quality, especially involving flavors, so it is understandable that there is desire for a sensory analysis course. Unfortunately we currently lack faculty in this expertise and teaching loads are already high. We will continue to augment sensory analysis in ANFS 429 and 411.

Food law and regulations: Aspects of these topics are taught in several of our courses. This semester, Kali Kniel is offering ANFS 567: Understanding FSMA, available to both undergraduate- and graduate-level students. This two-credit course analyzes the component sections of the Food Safety Modernization Act and comments to the rules posted by industry and produce growers. Case studies will be used to address how FSMA may affect public health. The course syllabus is included in the appendix of this document.

Teaching facilities: It is recognized that our teaching facilities require a freshening. As a small program we have used research equipment and research laboratories to supplement teaching facilities. Our administration also recognizes that our overall college teaching resources need to be refurbished, strengthened and centralized. WorriLOW Hall is where our primary teaching facility is presently located. Our dean has just approved funds for an evaluation of WorriLOW Hall by an architectural engineering firm for renovation of the building. This is the top priority of the college. It is estimated the renovation process will start in one to two years.

Additionally, the content and teaching style of our courses are continuously scrutinized in response to scientific or social developments and to the outcome of course evaluations and surveys. Virtually all of our courses have an active-learning component, use group activities to prepare students for professional teamwork, and incorporate extensive writing and presentation exercises. All our advanced Food Science courses have a laboratory component to provide practical experience. Field trips are part of course activities implemented to broaden student perspectives. We have a food-grade kitchen facility and have submitted a Unidel grant proposal to improve our small-scale pilot plant located in the Newton Building for the production of cheese as an area of growth for the UDairy Creamery.

How will the program build on existing strengths?

This is a question we continually ask ourselves. Our undergraduate curriculum is rigorous and produces well-rounded graduates. Consequently with our number of alumni growing and coming back for various campus events we plan to continue to develop these interactions to build our network, especially with our alumni now in industry. We are pointed in the right direction; therefore any drastic changes to our program would seem ill-advised at the moment.

External Program Review Report

**Department of Animal and Food Science
University of Delaware**

September 30 – October 2, 2013

REVIEW TEAM MEMBERS

Shawn S. Donkin, PhD
Associate Director of Agricultural Research and Director of Graduate Education, College of Agriculture
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National Program Leader, Animal Health and Well Being
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Washington, DC

James Lindsay, PhD
National Program Leader, Nutrition, Food Safety/Quality
USDA Agricultural Research Service
Beltsville, MD

Avron Abraham, PhD
Director, Center for Academic Success
University of Delaware
Newark, DE.

ACADEMIC PROGRAM REVIEW SCHEDULE

Monday, September 30, 2013

- 5:00 p.m. Arrive Newark, Delaware (Embassy Suites, 654 South College Avenue)
- 6:00-8:30 p.m. Dinner meeting with Dean, Acting Deputy Dean and Deputy Provost
- Dinner will be held at Embassy Suites. Please check with the front desk as this is currently scheduled in Fort Christina Room but this could change per the hotel.

Tuesday, October 1, 2013

- 7:30 – 8:30 a.m. Breakfast with Department Chair (233 Townsend Hall)
- 8:45 – 10:45 a.m. Tour of facilities (Townsend and WorriLOW Halls, O. A. Newton Building, Allen Laboratory, Newark and Webb Farms).
- 11:00 – 12:00 a.m. Meet with department faculty to discuss undergraduate programs. (Allen Laboratory)
- 12:00 – 1:00 p.m. Lunch with undergraduate students (Allen Laboratory)
- 1:00-2:00 p.m. Meet with department faculty to discuss graduate programs (Allen Laboratory)
- 2:00-3:00 p.m. Meet with graduate students (Allen Laboratory)
- 3:00-3:30 p.m. Break
- 3:30-4:30 p.m. Meet with department faculty to discuss outreach and research. Separate meetings will be held with faculty in the areas of Animal Genomics and Physiology, Large Animal Biosciences, Food Science, and Poultry Health and Management
- Food Science – Dallas Hoover (049 Townsend Hall)
 - Large Animal Biosciences – Limin Kung (233 Townsend Hall)
 - Poultry Health and Management – Jack Gelb (Allen Laboratory)
 - Animal Genomics and Physiology – Carl Schmidt (156 Townsend Hall)
- 4:30-5:30 p.m. Meetings with individual faculty/other stakeholders, as requested (049 Townsend Hall)
- 5:30 p.m. Back to hotel

6:30 – 8:00 p.m. Review team dinner with stakeholders at Embassy Suites. Please check with the front desk as this is currently scheduled in Christina River Room but this could change per the hotel.

Names of Stakeholders

Donald Ritter	Director of Health Services	Mountaire Farms, Inc.
Heather Hirst	State Veterinarian	Delaware Dept. of Agriculture
Lorenzo Nicasro	Senior Vice President	Atkins Nutritionals, Inc.
Chris Wacek-Driver	Forage Products Manager	VitaPlus
John Glisson	Director for Research	US Poultry and Egg Association
Stan Vonasek	President	Delaware Equine Council
Mark Tolbert	Program Manager	Campbell Soup Company
Bob Whitaker	Chief Scientific Officer	Produce Marketing Association
Kenny Bounds	Senior Vice President /Regional Manager	Mid Atlantic Farm Credit
John McCarty	Senior Veterinarian	Merial, Inc.
Andrea Jackson	Food Safety Programs	Delaware Dept. of Agriculture

Wednesday, October 2, 2013

7:15 – 8:15 a.m. Breakfast (Hotel)

8:30 – 9:30 a.m. Meet with department professionals and staff (Allen Laboratory)

9:30 – 11:00 a.m. Committee members on their own to prepare preliminary report (Allen Laboratory)

11:00 to 12:00 noon Exit interview with department (Allen Laboratory)

12:00-1:30 p.m. Lunch with Provost, Deputy Provost, and Dean and Acting Deputy Dean

1:30-2:30 p.m. Committee members on their own to discuss written report to be submitted one month after site visit

2:30 p.m. Leave for airport/home

INTRODUCTION

The Dean of the College of Agriculture and Natural Resources commissioned a review of the academic programs in the Department of Animal and Food Sciences (ANFS) at the University of Delaware. A comprehensive self-study document was provided to review team members in advance of the site visit. This document served to inform the review team of past accomplishments and strategic directions for the future for the department. Additional resources were provided as links to 2011 ANFS Strategic Plan and ANFS Master Plan. The review team considered the most important goal of our work to provide an outsider view of the department and help identify areas of strength and areas for improvement that would help to inform the decision making process for the future direction of the department.

The review team consisted of five individuals with current or past faculty experience in departments and colleges similar to the University of Delaware Department of Food and Animal Sciences and College of Agriculture and Natural Resources (CANR) in land-grant institutions. Two of the team members were USDA employees, one in ARS and a second in NIFA. One review team member was from within the University of Delaware. Disciplines and areas of expertise corresponding to programs in the Department of Animal Sciences as well as administrative experience were represented among review team members. While on campus, the review team met with the Dean of the College of Agriculture and Natural Resources; the Department Head; faculty representing all programmatic areas of the department; administrative professional, clerical, and service staff; undergraduate and graduate students; and stakeholders.

The review team members genuinely appreciated the efforts of the department faculty and staff in development of the self-study. The central themes of the self-study were helpful in providing perspective on the current state of the department and some indications of future goals of the department. The current review is timely given an emerging strategic plan for the CANR and the near future need to identify a new department head for ANFS. The department is positioned for change. The review team sought to identify strengths, weaknesses and to provide recommendations that would provide opportunities for national and international recognition given opportunities for new leadership. The team also specifically evaluated the dynamics of the current linkage of the disciplines of Animal Sciences with Food Science with regard to academic, research, and outreach programs.

EXECUTIVE SUMMARY

The review team concluded that ANFS was well-organized and administered. The Department Head was viewed as effective and well-regarded by ANFS faculty and staff. A concern related to resources returned to ANFS for the efforts invested/expended was readily apparent due to the impact of the responsibility based budgeting (RBB) and uncertainties surrounding this newly implemented budget structure.

Past departmental decision making has been viewed as fair and transparent with overall satisfaction regarding departmental administration. There appeared to be an understanding within the department, at this point in time, that a unique opportunity exists and that the choice of its future leader will be key to its future success. The department has a history of promoting

prominent researchers from within the department to administrative posts. While this leadership approach has served the department well, it likely has impacted the research productivity and hence current visibility of the department. Providing new leadership that would not compromise current research (or teaching) strengths of the department will benefit ANFS.

Several indicators of a healthy and positive culture existed in the department. Faculty, staff and students were proud of being part of ANFS and have a strong sense of ownership and commitment to the unit. The review team was impressed that 75% to 80% of the faculty were present at most of the general sessions during the on-campus visit. Faculty have shown great willingness to invest efforts to move the interests of the department forward as evidenced by extensive engagement in the development of the self-study documents, the ANFS strategic plan, and operational management in the department. Undergraduate and graduate students and the staff were equally engaged in the information /discussion sessions.–Clearly all groups within ANFS demonstrate an interest in the success of the department and appear willing to put forth the effort necessary to move the department forward. These traits will be crucial to strengthen the department’s future and must continue to be cultivated.

While the culture of the department was generally healthy, some apprehension concerning the future existed among the faculty. Shifts in certain paradigms required some redirection of faculty focus and effort:

- Uncertainty regarding the resources returned to the department for effort and the lag in updating resource allocations back to the department in the current RBB model
- Limited physical capacity and personnel to meet expanding needs for hands-on learning
- Cost of hands-on learning in laboratories and at ‘the farm’ relative to available funds to cover these costs
- Disproportionate number of entering students with career goal expectations of veterinary medicine and ultimate career paths in animal and food sciences
- Continual shifts in the availability of extramural funding and evolving expectations for increased participation in the federal competitive arena
- Shifting emphasis for funding and programmatic priorities towards interdisciplinary work yet concerns that RBB model does not foster interdisciplinary efforts.
- A need to identify unique strengths and opportunities for prominence as a research entity within the land grant system and as part of the USDA-NIFA research portfolio
- Defining an academic program within the agricultural and food systems space that best matches the immediate needs of students and emerging societal needs
- Accommodating an increasing student enrollment with a lack of growth in departmental infrastructure for teaching and learning

ANFS Faculty have been internally focused and preoccupied on issues related to: 1) the uncertainty of teaching resources, 2) implementation of RBB and 3) diversifying the curriculum to attract a broader audience of students. Other challenges include the increasing costs of instruction for core courses in ANFS and inability to increase enrollments due to space needs. The cost per credit hour for ANFS courses is more than twice that of the national average and is not likely not sustainable in the RBB model. New innovative courses have been developed to meet some of the challenges faced by ANFS . The exceptional value and level of satisfaction that students placed on the quality of instruction for courses in ANFS was readily apparent. The

review team recommends identifying mechanisms to reduce the costs of instruction for ANFS intensive courses while expanding the audience for general interest courses.

Undergraduate students unanimously indicated that the presence and proximity of the ANFS Newark farm was a major factor influencing their decision to enroll at the University of Delaware. ANFS and UD administration appeared to explore the appropriate mix of space utilization that retained enough livestock for teaching and research at a cost that the department and college can manage. The review team recommends the following 1) retention of the facilities, 2) continuation of experiential learning with livestock production practices, 3) Explore potential growth area for use of the facility including research that addresses issues around the urban and rural interface of food animal production. The latter may involve several programs in CANR and across campus. 4) consider renaming the facility to indicate the varied facets which could cause others to see it as a resource.

There appeared to be a lack of connection between the overall research and education goals of ANFS and CANR. For example, the CANR plan of work has broad goals in areas including Global Food Security and Hunger, Biotechnology and Biotechnology-Based Agribusiness, Food Safety, Climate Changes and others yet there was a lack of corresponding links to department research themes. Faculty research programs do not seem to identify with these broader goals. Similarly, there is a lack of deliberate connection to the undergraduate curriculum. Consequently, instructional and research strength areas are not uniquely evident for the department. Research efforts appeared to be siloed in individual PI programs. The cross cultural and synergistic potential of the unique combination of faculty and students that represent the continuum of food system is not being fully availed. The review team recommends that the department identify research ‘challenge’ areas or ‘themes’ that will enhance faculty connections with the common purpose of solving identifiable problems in food and agriculture .

The department has some demographic characteristics that favor continued evolution in culture and expectations. Of the 21 tenure-track faculty in the department at the time of this review, 6 are assistant professors, 7 are associate professors and 8 are full professors. Two assistant professors will be leaving the department. Given the growth in enrollment, it is important for the College of Agriculture and Natural Resources to support faculty hiring in ANFS as vacancies occur. The review team recommends ANFS prepare a plan for faculty hiring based on critical teaching needs that intersect ANFS research portfolio and an evolving undergraduate curriculum. A further recommendation is to enhance ANFS research portfolio with faculty hires that will bridge the disciplines of avian biology and food sciences and help to unify the research program in the food systems area.

A deficit of the review process was a lack of discussions with collaborating departments within the college or university. While this may have been an oversight, it could be a symptom of an inwardly focused department. Though faculty revealed partnerships in the areas of genomics and potentially bioinformatics, other associations were not evident. The review team recommends: 1) ANFS faculty exploring opportunities to become engaged and assume greater leadership in University-wide initiatives focused on the biological sciences. 2) The CANR administration should offer opportunities to engage faculty across campus in a way that complements the mission of ANFS but broadens opportunities for research support. Animal scientists, food scientists, and disciplinary specialists in the department have much to offer and

the stature and credibility of ANFS will be enhanced as the visibility of the faculty increases within UD.

Extension activities were not highlighted separately in the review however several faculty members indicated during breakout sessions that they contribute to Extension and provide important services to stakeholder groups. Activities ranged from responding to individual stakeholder needs to research on production practices with immediate application to the industry (i.e. evaluation of house lighting, litter, composting of litter and farm mortality, litter substrates such as switch grass, cow lameness detection models and silage preservation technologies). Likewise services that bridge research, teaching, and extension were evident in the department. The latter includes the diagnostic laboratories, the histopathology service, vaccine certification services. While these activities are on the leading edge for identifying problems for the industry they can also spin off data and new pathogen isolates for research. Overall, the integration of extension with research programs appears to be a strength area of the department

In order for the department to grow capacity for basic research in support of an already strong applied research enterprise, attention must be given to the aging and inadequate laboratory space in the Worrilow Hall and the Newton Building. Aspirations for expanding the department's reach in basic sciences and increasing the prominence of the graduate student enrollment will be limited by the availability of high quality space. The review team recommends UD support the plans for renovation of Worrilow Hall, and develop an adequate food sciences sensory lab and pilot plant space; otherwise strengthening the stature of ANFS among peer institutions will be hampered.

Recommendations

- The overall focus of ANFS should transition from the internal issues that have occupied much of its attention for the past several years to implementation of its plans towards greater engagement and leadership in college- and University-wide initiatives.
- ANFS must assess the balance of its research funding profile and continue to diversify external funding sources. Some opportunities may exist in growth of genomics and bioinformatics funding opportunities.
- Define the department. The mission of the program is not clear, and consequently detracts from program in both Animal Sciences and Food Science. The department appears to function as two disciplines that share the same administrative resources. Joining of the discipline areas is a strength that should be exploited but will take effort and compromise to define. A departmental name that does not include 'and' may be a move in the right direction.
- Consider increasing emphasis on expertise of future faculty areas that bridge traditional animal science disciplines and food sciences research areas.
- To be competitive in justifying new faculty positions and filling positions vacated by retirement, ANFS should have a strategic plan for faculty composition that will fulfill essential teaching needs and present creative and nimble research foci.
- Focus on ways that ANFS can enhance the diversity of its faculty.
- Develop a plan for ANFS and CAFR research and teaching space that allows for flexibility and anticipates growth

RESEARCH PROGRAMS

One charge to the review team was to consider was *“How well are research programs supported and what strength of training do they lend to graduate programs”* The available databases that make comparisons among Animal Science Departments or Food Science Departments in different institutions much less in departments where the disciplines were in demand were limited. The review team will offer some comments on faculty and graduate student numbers, publications, and grant funding.

Data from the U.S. Education Department indicates that The University of Delaware has selected 12 peer institutions for program planning and comparisons (<http://chronicle.com/article/Who-Does-Your-College-Think/134222/>) . These institutions were: Boston College, Brown University, College of William and Mary, Carnegie Mellon University, Georgia Institute of Technology, Lehigh University, Penn State University, University Park, University of Maryland, College Park, University of North Carolina, Chapel Hill, University of Notre Dame, University of Pittsburgh main campus and University of Virginia. Only Penn State and University of Maryland have Animal and Food Science programs. During the review team visit Cornell University and Virginia Tech were also included as peers due to geographic proximity and potential competition for students.

Data provided to the review team on publications and grant funding originated from compilation by Academic Analytics (www.academicanalytics.com), a tool now being employed by some institutions to evaluate research outcomes in a context of peer comparison. Publication and grant data represented a compilation of 2007-2013. The team was not able to access the database for comparisons but data provided indicated that the Department scored above average for citations, grants and publications and at average for conference proceedings but below average for awards. The NRC doctoral program data (<http://www.nap.edu/rdp/index.html?#download>) indicated that for Animal Sciences, UD did not match the publication output of peers with Animal Science programs. Although this represented 2000-2006 data, a lack of significant upward trend in numbers of publications from the department since 2006 suggested a similar situation currently exists. The NRC data indicated that UD Animal Science ranked highly for average citations per publication. This may be a sign that faculty might benefit from increased publications or assistance with the writing process.

Discussion around the area of grants development, budgets and grants submission indicated a heavy burden on the administrative assistant to the department head. Support for the grants budgeting process or a process to facilitate collaboration on grant application within ANFS or with other departments in CANR was not apparent. The review team recommends research administrative support to enable increased research collaborations and external grant submissions.

The faculty has organized themselves into Food Science, Large Animal Biosciences, Poultry Health and Management, Animal Genomics, and Physiology for the review. It was not apparent whether these were cohesive working groups or categories that were used only for the review. The review teams recommended development of problem-based research groups rather than the existing discipline areas. There is an advantage to be gained by the complementation of

faculty expertise even within ANFS. Some members within research groups appear to function insularly, while successful in these niche areas, there would appear to be opportunities to synergize with others to explore untraditional research opportunities. Junior faculty members should be encouraged to explore alternative ways to use their expertise in new (collaborative) ventures. The CANR and ANFS should consider mechanisms that facilitate research team building. The department should explore opportunities to apply on-going research of Food Science faculty to animal (poultry) products (i.e. application of expertise in high-pressure processing). Sabbatical leaves should be encouraged if needed for faculty to retool or develop new skillsets that would enhance development of high functioning research teams.

Observations, Concerns, and Recommendations

- Research organized into disciplines rather than problem areas
- Lack of consistent of quality of research space across the department (ABC vs. other research facilities, lab space quality).
- Lack of identity of core research strength(s) and organization of research effort.
- Lack of evidence of core research support within the department (i.e. capability for RNA-seq is not well developed at core UD facilities)
- Lack of organized effort and support to build research teams
- Lack if cross and within disciplinary research synergy (i.e. Food and Animal)
- Future additions to the Food Science faculty should consider a research direction more closely aligned with poultry products processing or one that bridges the production and food areas

UNDERGRADUATE PROGRAM

The department has the largest enrollment of undergraduate students in the College of Agriculture and Natural Resources (approximately 384 students in fall 2013) and enrollment has been increasing steadily for the past 5 years. The undergraduate program exemplifies one of the department's greatest strengths. Faculty and AP staff who are engaged in undergraduate teaching clearly have great dedication to this mission and discuss it with insight and thoughtfulness. Animal Sciences students at UD are beneficiaries of a strong culture of commitment to undergraduate education by the faculty. The impact of the commitment to teaching is evident in conversation with undergraduate students and data from exit surveys.

As indicated above there are several concerns about the impact of RBB on the ability of ANFS to continue to provide meaningful 'hands on' experiential learning in laboratory spaces and at the Newark Farm. There is increasing pressure to justify the expense of Newark Farm. Students and faculty stressed the values of this facility as a hub for research and extension as well an outdoor laboratory. Many students come to ANFS at UD because of this space and there appears to integrate greater use of the facility in discovery learning and other activities that may cut across many disciplines at the university. There are very few institutions of higher learning in urban areas that have such a space available so close to campus. This provides a unique opportunity for CANR and ANFS to set their programs apart.

The department recognizes that the equine sector is growing segment of agriculture in DE and has invested in on-campus facility to enable instruction and extension in equine sciences. This complements the overwhelming interest of undergraduates towards veterinary careers of which equine represents a keen interest. With this said the departure of the sole equine sciences faculty member provides an opportunity to redirect the program particularly the equine sciences minor. The minor program, although generously funded, does appear to be tangential to the main focus areas of the department of animal sciences and food science. An equine science minor would also appear to splinter a segment of animal sciences to a separate program and further contribute to the lack of unified identify for the department.

Observations, Concerns, and Recommendations

- Faculty exercise liberty to change lecture times to unconventional times and causing conflicts with regularly scheduled classes.
- The coherence of the undergraduate curriculum with, for example seniors taking sophomore level physics, and taking it as a co-req not a pre-req. There was the impression that there may be a problem in taking comparative physiology their senior year.
- Students that have taken part in the undergraduate research program indicated the powerful impact the experience had on their learning and suggested the department provide more opportunities for students to engage in research early in their academic program.
- Adequacy of food science pilot plant and kitchen. The team recommends upgrading the Food Science lab and teaching facilities
- The number of food science classes within the curriculum meets the standards set by IFT but offering more courses would be difficult given the number of faculty in the program.
- Future ability to support teaching at the Newark farm may be limited due to cost however this is a genuine strength of the program. The committee recommends exploring opportunities to maintain and broaden access to the facility.
- Potential for greater emphasis on internships and coop programs in the Food Science to ensure that students gain “hands-on” skills are not being fully exploited. These should complement the capabilities normally associated with laboratory and pilot facilities in larger programs but would add value and differentiate the UD program from other Food Science programs.
- The historical departmental strength in poultry health and production does not appear to be integrated into the food science curriculum. The review team recommends future hires that span both areas as a way to bring these areas closer.
- Food Science does not appear to be fully engaged with food industries in the region. Undergraduate programs should look to expand opportunities to respond to the unique expectations of the food industries in the region
- Exposure to research opportunities is important for undergraduate success. Increase opportunities for students to engage in discovery learning early in their academic program. Seek ways to use ‘the farm’ to engage more students in discovery learning at an earlier phase in their program.

- The department seems isolated from other activities on campus. Continue to explore ways in which the department could expose the larger university student body to ANFS through the development of unique and exciting courses that meet university breadth requirements, the creation of minors focused specifically on those students that may have a strong science background and an interest in animal and/or food science. Consider ways in which the strength of the departmental capstone experience can be leveraged through interdepartmental collaborations across campus. Continue to provide resources and support such as the “AGcelerate” program with an emphasis on diversifying the student body.
- Full potential of ‘the farms’ are not being met. Explore increased utilization of the farm as a teaching/learning opportunity for not only CANR students but the broader campus, considering collaborations across campus with related areas. Examples could include but not be limited to environmental sustainability, nutrition, human services, etc.

GRADUATE PROGRAM

The Animal Sciences graduate program is strong and vibrant. The faculty members are well qualified to train both PhD and MS students for positions in industry or academia. Full professors are well established in their respective research areas and provide a firm foundation for graduate education. Additionally, the faculty contains 6 assistant professors and 7 associate professors. These new faculty are well qualified to provide state of the art research training to graduate students and to obtain competitive grant funding to support graduate students and research. The department has equal number of MS students in Food Science and in Animal Science (15 and 17 respectively) but disproportionately fewer faculty member that identify with Food Science in listing their area of expertise (self-study document section 5.5). There are 8 PhD students in Animal and Food Science and in interviews with students some of these appear to be part of interdisciplinary programs.

Graduate students appear to be content with the curriculum and research opportunities. Students valued the open door policy of faculty and the willingness to share expertise. Likewise the flexibility in graduate programs is a desirable feature for students. Students communicated that the requirements for the degree, as stated on the web site and other sources, are confusing and needs work. There does not seem to be a mechanism to provide students with information on progress towards degree and a lack of clear sense for expectations for MS and PhD programs and how these are met in the program.

Observations, Concerns, and Recommendations

- Overall impression of the graduate program was quite positive
- Learning outcomes (i.e. problem solving, creative and critical thinking, project management, core discipline knowledge) for graduate programs are not outlined consequently students appear uncertain about the reasons for engaging in specific courses or activities.
- Responsible conduct in research education is not being observed as a requirement for graduate education. This is a requirement by many funding agencies that cannot be overlooked and an ability to conduct research in a responsible and ethical manner should be a learning outcome for all graduate programs.

- The department utilizes several TAs and a group of students are funded as departmental teaching assistantships. Several graduate students expressed that they did not have an opportunity to experience teaching and that felt they would be discouraged from spending time pursuing experience in teaching. The department is encouraged to explore this further and provide opportunities, release time from research if necessary, credit and rewards for engaging in professional development around teaching and learning.
- In exit surveys and in personal interviews with the review committee, graduate students indicated a high level of satisfaction with courses and advising. Although communication between graduate students and their individual advisors appears to be effective, the interaction and communication between graduate students across subject appears to be minimal.
- Graduate enrollment could increase while seeking alternative ways in which to offer graduate programs. This could include non-thesis, 4 plus1 programs, on-line or hybrid courses, developing certificate programs etc.
- More teaching opportunities for graduate students
- Clarity in the requirements and a web site that provides consistent information
- Opportunities for graduate students to take courses in areas where they make lack the requisite background.
- Consider ways to increase the diversity of graduate student population

STAKEHOLDERS

The review team met with several stakeholders for key programs in Animal Sciences teaching, research, and extension. These key programs encompass multi-species program areas given the diverse nature of animal agriculture in the state including regulatory agencies, producer groups, food processing and marketing organizations, livestock industries, and agricultural service. There was enthusiastic support for the future of the ANFS department. Participants recognized that there were challenges in bringing together the disciplines of food and animal sciences but expressed the unique aspect of the combination. When asked directly there was strong support by the stakeholders that the combined disciplines represents an opportunity for ‘strength in synergy’ rather than a dilution of impact through ‘competing priorities’.

Recommendations:

- Encourage formation of a Department External Advisory Board to identify areas where effort should be concentrated and to identify needs to achieve excellence.
- Connect more frequently with stakeholders
- Explore stakeholder commitment to enhance research and education in the department.
- Engage stakeholder in identifying resources needed to enhance facilities, programs and research capacity for the department
- Explore the specific needs of the stakeholders with respect to potential employees, internship opportunities, research, education and services which ANFS could provide.
- Explore ways to balance the differences in the stakeholder expectations for teaching, research and service for the Animal Science and Food Science areas with a need to create an identity in the department.

OVERALL PROGRAM RECOMMENDATIONS

- Consider the name of the department and whether it is appropriate as the department moves forward implementing its strategic plan. Possibly consider a generic name that encompasses a wider range of biology related to agriculture and food.
- Build on the opportunity provided by the farm, which may include the consideration of its current strengths and challenges and how this outstanding urban based resource could be leveraged to better serve the college, university, local community and nation.
- Take full advantage of the expected change in departmental leadership to better define the departmental priorities regarding academic programs, research and faculty hires.
- Explore ways to enhance the food science program by upgrading the facilities, and considering curriculum, revisions which better reflect the departmental strengths, without compromising national certification.
- Engage initiatives that build teams within research programs in the department using the traditional disciplines of food and animal science to uniquely position the department for solving problems and greater and more varied extramural research support.
- Build on the goodwill of the stakeholders and local community to specifically enhance opportunities for discovery learning for students and research support for faculty.
- Explore curriculum innovations that provide opportunities for both ANFS students and the broader university through the development of exciting and innovative undergraduate courses, minors and certificate programs that build on the unique aspects provided by the farm and faculty expertise.
- Vigorously pursue a new department head from external candidates. Consider and recruit individuals with a very broad range of ideas and experience both nationally and internationally. The department will likely benefit from a leader with strong management skills. An individual with experience with RBB budgeting models would be an asset. The department/college has the potential to be exceptional, but it needs strong and different leadership to excel in the current academic environment. While there are several talented faculty leaders in the department the previous practice of promoting from within is discouraged.

January 8, 2014

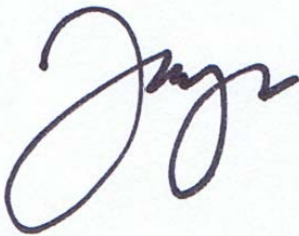
To Whom it May Concern:

I am writing to request permanent status be given to the undergraduate major, *Food Science*, offered by the Department of Animal and Food Sciences.

This major has been highly successful in preparing students for careers in the field of food science and food safety. Virtually all of our graduates receive multiple job offers upon graduation and earn very competitive starting salaries in food companies in Research and development, production and marketing. The numbers of students in the major have been steadily increasing over the last 5 years due in large part to active recruiting effort by our faculty and the quality of our program. The major curriculum is rigorous and also prepares students for success in graduate schools in M.S. and Ph.D. programs.

The major, a key program in our Department's and College's Master Plan, has been identified as an area for continued enrollment growth and emphasis.

Thank you for your consideration.



Jack Gelb, Jr.
Professor and Department Chair



College of Agriculture
& Natural Resources

OFFICE OF THE DEAN

113 Townsend Hall
531 South College Avenue
Newark, DE 19716-2103
Phone: 302-831-2501
Fax: 302-831-6758

January 10, 2014

To whom it may concern:

I support the permanent approval of the following majors in the College:

Pre-veterinary Medicine
Food Science
Animal and Food Sciences

Enrollment has either reached desired levels or is increasing on the anticipated trajectory in all cases. The Animal and Food Sciences major will undergo minor curricular revision during the 2014 calendar year as will several majors in the college as we implement our new strategic plan.

Thanks for your consideration.

Sincerely,

A handwritten signature in black ink, appearing to read 'Mark Rieger'.

Mark Rieger
Dean and Professor
College of Agriculture and Natural Resources, University of Delaware

cc: Dr. David Frey
Dr. Kalmia Kniel
Dr. Jack Gelb