The Pennsylvania State University
Department Of Food Science
Undergraduate Program Handbook

Program Year 2011

Prepared by:

The Undergraduate Program Committee

Department of Food Science

Revised:

August 2011

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What Is Food Science?

Food Science is the application of science and technology to the development, processing, packaging, storage and distribution of food products from the farm to the consumer. This professional field covers many disciplines, including chemistry, microbiology, nutrition and engineering. **Food Science** plays an important role in the health, welfare and economic status of individuals and nations. **Food Science** serves society by assuring availability, abundance, affordability, wholesomeness and safety of food. **Food Science** is an independent professional discipline with its own professional society, *The Institute of Food Technologists* (http://www.ift.org).

Why Major In Food Science?

Food Science offers a lifetime vocation in the maintenance of a never-ending stream of quality food products. You may want to choose Food Science as a career if you are interested in science and want to apply it to real-world problems. You can do this by:

- researching the biological, chemical and physical nature of food and food components.
- developing new food products, processing methods or distribution techniques.
- improving the nutritive value of food products.
- supervising raw material procurement or managing any aspect of a food processing operation.
- maintaining high standards of safety and sanitation and managing quality of an ever-increasing variety of food products.

What Are Some Career Opportunities In Food Science?

Penn State food scientists have found employment throughout the United States and around the world. Because of the constant need for qualified food scientists, salaries are generally equal to or higher than salaries of other professions requiring equivalent levels of education. The following listing provides insight into the types of positions available.

Product Development: Graduates are involved in developing new food products or improving the quality, performance, and/or safety of existing products. These positions require a creative flair, sensory evaluation expertise, and the ability to work in teams.

Research and Development: Persons employed in research and development for a food company use their microbiology, chemistry, engineering, or nutrition skills to investigate scientific principles and phenomena as they pertain to specific food components, food products,

or food processes.

Technical Support: Graduates in technical support combine their knowledge of raw materials and ingredients with food processing applications. Often they work closely with product development specialists in the manufacture of food products.

Management: Managers of manufacturing facilities are involved in the organization, operation, and development of food processing companies. Their key role is to oversee employees and operations in the processing of specific foods.

Quality Assurance: Quality assurance and quality control specialists analyze the components of food products and monitor the finished product for conformity to company and government standards.

Regulation: Graduates are involved at the state or federal government level with agencies such as the USDA, FDA, EPA, Homeland Security and the Patent Office. Positions include policy development, enforcing food sanitation and labeling regulations, or ensuring the safety of our food supply.

Extension Education: Extension educators specializing in food safety, food processing, or human nutrition use a variety of educational methods, including group meetings, workshops, mass media, and electronic methods to deliver educational information.

International: Many larger food companies are multinational and employ graduates with international experience or who speak a foreign language. Graduates looking to expand their horizons can be involved with helping citizens of developing nations improve their food handling and storage procedures through agencies such as the Food and Agriculture Organization, World Health Organization, or the Peace Corps.

Food scientists with an interest in teaching and research may find rewarding scholarly careers in educational institutions. An academic career usually requires an advanced degree and research specialization in a particular area, such as food chemistry, microbiology, toxicology, engineering or nutrition.

What Are The Course Requirements For A Food Science Major?

Prerequisite courses in chemistry, mathematics, physics, biology and microbiology are usually completed within the first two years of the program. Entrance into Food Science courses can begin as early as the first year. Supporting courses are chosen according to your academic and career interests and allow you to individualize your academic experience.

For the B.S. degree in food science, a minimum of 128 credits is required.

Course Requirements of a Food Science Major

	Scheduling Recommendation by semester standing			
	1-2	**3-4**	**5-6**	**7-8**
General Education: 45 credits (18 of these 45 credits are included in the **Requirements For The Major**)	X	X	X	X
Electives: 10 Credits	X	X	X	X
Requirements For The Major: 91 credits (This includes 18 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GWS courses)*				
Prescribed Courses (61 credits)				
CHEM 110 GN(3), 111 GN(1), 112 GN(3), 113 GN(1), BIOL 110 GN(4), FD SC 200(3)	X	-	-	-
FD SC 201(1), PHYS 250 GN(4), MICRB 201(3), 202(2), BMB 211(3)	-	X	-	-
BMB 212(1), FD SC 400(4), 405(3), 406(3), 408(2), 409W(3), and 410(3)	-	-	X	-
FD SC 411(2), 413(3), 414(3), 415(3), 430(3)	-	-	-	X
Additional Courses (16-18 credits)				
MATH 110 GQ(4) or MATH 140 GQ(4)	X	-	-	-
CHEM 202(3), 203(3); **or** CHEM 210(3), 212(3), 213(2)	-	X	-	-
ENGL 202C GWS **or** 202D GWS(3)	-	-	X	-
STAT 250 GQ(3)	-	-	X	-
Career Interest Courses and Related Areas (12-14 credits)	-	-	X	X
To reflect the student's career interests, select 12-14 credits from the department list or in consultation with advisor				

*Courses satisfying General Education requirements have a multi-capital letter suffix: courses with the GN designation may be applied toward the 9-credit requirement in Natural Science; those with the GWS designation may be used to satisfy the 9-credit Writing/Speaking requirement; and those with the GQ designation may be used to satisfy the 6-credit Quantification requirement. Because Food Science is a scientific discipline, the GN requirements are fulfilled by science courses taken as a requirement for the major.

Students must complete at least one 3-credit writing intensive course, selected from "W" courses offered in the major (FD SC 409W), **3** credits of United States Cultures (US) and **3** credits of International Cultures (IL), and 2 credits of a Freshman Seminar course (AG 150S recommended).

Tabular Outline of the Requirements for Food Science B.S.

First Semester (Fall)		Second Semester (Spring)	
CHEM 110 Chemical Principles	3	BIOL 110 Biology:Basic Concepts & Biodiversity	4
CHEM 111 Experimental Chemistry	1	CHEM 112 Chemical Principles	3
MATH 110 Techniques of Calculus I **or** MATH 140 Calculus with Analytic Geometry	4	CHEM 113 Experimental Chemistry	1
		FD SC 200 Introductory FD SC*	3
AG 150S First-Year Seminar	2	GHA (GHS, ESACT)[1]	1
ENGL 15 Rhetoric & Composition (FA or SP)	3	Arts Selection (GA)[1]	3
Social/Behavioral Science Selection (GS)[1]	3	Elective[3]	2
Total Credits	16	Total Credits	17

Third Semester		Fourth Semester	
CHEM 202 Organic Chemistry **or**	3	CHEM 203 Organic Chemistry **or**	3
CHEM 210 Organic Chemistry	3	CHEM 212 Organic Chemistry **and**	3
PHYS 250 Introductory Physics I	4	CHEM 213 Organic Chemistry Lab	2
(Schedule PHYS 250P as part of PHYS 250)		BMB 211 Introductory Biochemistry	3
FD SC 201 Introductory FD SC Lab*	1	MICRB 201 Introductory Microbiology	3
CAS 100A Effective Speech	3	MICRB 202 Introductory Micro Lab	2
GHA (GHS, ESACT)[1]	2	Arts Selection (GA)[1]	3
Humanities Selection (GH)[1]	3	Social/Behavioral Science Selection (GS)[1]	3
Total Credits	16	Total Credits	17-19

Fifth Semester		Sixth Semester	
FD SC 400 Food Chemistry*	4	FD SC 405 Food Engineering Principles*	3
FD SC 408 Food Microbiology*	2	FD SC 410 Chem Methods of Food*	3
FD SC 409W Food Micro Laboratory*	3	FD SC 406 Physiology of Nutrition*	3
BMB 212 Introductory Biochem Laboratory	1	STAT 250 Biostatistics	3
ENGL 202C Technical Writing **or**		Career Interest Course[2]	3
ENGL 202D Business Writing	3	Career Interest Course[2]	2
Humanities Selection (GH)[1]	3		
Total Credits	16	Total Credits	17

Seventh Semester		Eighth Semester	
FD SC 413 Sci & Tech of Plant Foods	3	FD SC 411 Managing Food Quality	2
FD SC 414 Sci & Tech of Dairy Foods	3	FD SC 415 Sci & Tech of Muscle Foods	3
Career Interest Course[2]	3	FD SC 430 Unit Oper Food Prod	3
Career Interest Course[2]	3	Career Interest Course[2]	3
Elective[3]	3	Elective[3]	3
Total Credits	15	Total Credits	14

United States Cultures (US) and International Cultures (IL) requirement satisfied by: (6 credits)

_____ _____

Writing across the curriculum requirement satisfied by: _____

*Indicates "C" required course (Senate Policy 82-44)

[1]Select from University approved General Education Lists.

[2]Select from an approved list, or in consultation with advisor (see p. 10); 14 credits required if CHEM 202 & 203 taken, 12 credits required if CHEM 210, 212, & 213 taken.

[3]Select elective courses in any area of interest.

What Undergraduate Courses Are Offered By The Department Of Food Science?

FOOD SCIENCE (FD SC)

105. (GHA) (STS 105) FOOD FACTS AND FADS (3:3:0) Impact on society and the individual of modern food technology, food laws, additives, etc.; historical, current, futuristic aspects. Steele

197. SPECIAL TOPICS (1-9)

200. INTRODUCTORY FOOD SCIENCE (3:3:0) General overview and principles; food constituents and properties; quality and safety; preservation methods; processing animal and plant products.. Prerequisite: CHEM 110 Roberts

201. INTRODUCTORY FOOD SCIENCE PRACTICUM (1:0:2) Demonstrations to illustrate actual chemical reactions in food systems and visits to campus and area food production and processing operations. Prerequisite or concurrent: FD SC 200. Ziegler

207. (AN SC 207) ANIMAL PRODUCTS TECHNOLOGY (2) Composition, safety, palatability, preservation, and processing of foods from animals, impact of animal production and handling practices on product properties. Mills

208. (AN SC 208) ANIMAL PRODUCTS TECHNOLOGY LABORATORY (1) Harvesting and processing of foods from animals; hands-on and demonstration exercises; industry procedures for processing meat, milk, and egg products. Prerequisite: or concurrent: AN SC 207 Mills

280H. (GH) (PHIL 280H) FOOD, VALUES, AND HEALTH (3) The perceived relationship between food and health, emphasizing the conceptual nature of both; and how values contribute to the relationship. Thompson

297. SPECIAL TOPICS (1-9)

397. SPECIAL TOPICS (1-9)

400. FOOD CHEMISTRY (4:3:3) Chemical properties of food constituents as influenced by processing and storage. Selected experiments and demonstrations to illustrate chemical reactions of importance in foods. Prerequisite or concurrent: CHEM 202, BMB 211, BMB 212 Coupland

404. SENSORY EVALUATION OF FOODS (2:1:2) Sensory evaluation of food, methods of test analysis, panel selection and training, taste sensation theory, consumer testing methods. Prerequisite: STAT 250 or STAT 240. Hayes

405. FOOD ENGINEERING PRINCIPLES (3:2:3) Engineering principles of importance to food manufacturing, including units, dimensions, mass and energy balance, fluid flow, rheology, heat transfer, and psychrometrics. Prerequisites: MATH 110, PHYS 250 Anantheswaran

406. PHYSIOLOGY OF NUTRITION (3:3:0) Physiological mechanisms involved in thirst and appetite, digestion, absorption, utilization of nutrients, respiration, and body temperature regulation. Prerequisite: B M B 211 Thompson

407. FOOD TOXINS (2:2:0) 2) Microbiological and chemical aspects of food poisoning; toxicological principles; case histories and prevention of problems. Prerequisite: senior standing in food science or related majors

408. FOOD MICROBIOLOGY (2:2:0) Significance of microorganisms in food commodities, microbial spoilage, food-borne infections, and intoxications; methods of preservation, processing, and control. Prerequisite: MICRB 201, 202.
Doores

409W. FOOD MICROBIOLOGY LABORATORY (3:1:4) Methods of isolation and detection of spoilage and pathogenic microorganisms in foods; effects of processing and preservation on survival of food microorganisms. Prerequisite: MICRB 202. Prerequisite or concurrent: FD SC 408. Doores

410. CHEMICAL METHODS OF FOOD ANALYSIS (3:2:3) Qualitative and quantitative determination of food constituents. Prerequisite: BMB 212, FD SC 400.
Elias/Roberts

411. MANAGING FOOD QUALITY (2:2:0) Principles and applications of Hazard Analysis Critical Control Points. Statistical tools for the control and improvement of food quality. Prerequisite: FDSC 408, STAT 250. Ziegler

413. SCIENCE AND TECHNOLOGY OF PLANT FOODS (3:2:3) Physical and chemical behavior of plant-based raw materials and ingredients, with emphasis on parameters influencing finished product quality. Prerequisite: FD SC 400, 405, 408, 410. Elias/LaBorde

414. SCIENCE AND TECHNOLOGY OF DAIRY FOODS (3:2:3) Physical and chemical behavior of dairy-based raw materials and ingredients, with emphasis on parameters influencing finished product specifications. Prerequisite: FD SC 400, 405, 408, 410.
Roberts

415. SCIENCE AND TECHNOLOGY OF MUSCLE FOODS (3:2:3) Physical and chemical behavior of muscle food commodities, with emphasis on muscle-based ingredients in formulated foods. Prerequisite: FD SC 400, 405, 408, 410. Mills

430. UNIT OPERATIONS IN FOOD PROCESSING (3:2:2) Thermal processing, refrigeration, freezing, dehydration, and concentration in the food industry, including effects on food quality, food packaging and waste management. Prerequisite: FD SC 400, 405, 408.
Anantheswaran

495. INTERNSHIP (1-18) Supervised off-campus, non-group instruction including field experiences, practical, or internships. Written and oral critique of activity required. Prerequisite: PRIOR APPROVAL OF PROPOSED ASSIGNMENT BY INSTUCTOR
Doores

496. INDEPENDENT STUDIES (1-18) Creative projects, including research and design, which are supervised on an individual basis and which fall outside the scope of formal courses. A specific title may be used in each instance and will be entered on the student's transcript.

497. SPECIAL TOPICS (1-9) Formal courses given infrequently to explore, in depth, a comparatively narrow subject which may be topical or of special interest. Several different topics may be taught in one year or semester. A specific title may be used in each instance and will be entered on the student's transcript.

497A. BIOACTIVE COMPONENTS IN FOODS (2) Lecture course covering the occurrence, evidence for activity, potential uses, and safety of important classes of non-nutrient biologically-active food components. Lambert

497G. MOLECULAR BIOLOGY METHODS FOR FOOD MICROBIOLOGY (3) Lecture and laboratory-based course covering DNA-based methods for detecting and tracking microorganisms in food products. Dudley

What Career Interest Courses Are Available

To The Food Science Major?

Career Interest courses are chosen according to a student's academic or career interests. These courses allow the student to individualize his or her academic experience related to the major. Career Interest courses may be chosen from the departmental list of approved courses (below) or in consultation with the adviser. The number of career interest course credits required varies according to the credits obtained as additional courses (see p. 6).

Department	Course Number	Credits	Title	Prerequisites
ACCTG	211	4	Financial and managerial accounting for decision making	
AG BM	102	3	Economics of the food system	
AG BM	106	3	Agribusiness problem solving	AG BM 101
AG BM	200	3	Introduction to agricultural business management	
AG BM	302	3	Food product marketing	AG BM 101, AG BM 102, AG BM 106
AG BM	320	3	Markets and prices: analysis and forecasting	AG BM 101, AG BM 102, AG BM 106
AG BM (IL)	338	3	Agribusiness in the global economy	AG BM 101, AG BM 102, AG BM 106
AG BM	440	3	Food product innovation management	AG BM 302 or 6th semester standing in food science
AG BM	460	3	Managing the food system	AG BM 320, AG BM 338
AG EC (IL)	450	3	International development, renewable resources, and the environment	6 credits in agricultural economics or economics
AG	400	4	Biometry/statistics in the life sciences	6 credits in the natural sciences
AGECO (R SOC)	134	3	Sustainable agriculture science and policy	
AGRO (BIOTC)	460	3	Advances and applications of plant biotechnology	BIOL 230W, B M B 251
AN SC	100	4	Animal agriculture	
AN SC (FD SC)	207	2	Animal products technology	
AN SC (FD SC)	208	1	Animal products technology laboratory	Prerequisite or concurrent AN SC (FD SC) 207
B M B	251	3	Molecular and cell biology I	CHEM 112
B M B (MICRB)	252	3	Molecular and cell biology II	B M B 251
B M B	401	3	General biochemistry	CHEM 212; B M B 251 or BIOL 230
B M B	402	3	General biochemistry	B M B 401 or CHEM 476
B M B (VB SC)	433	3	Molecular and cellular toxicology	B M B 401
BIOL	141	3	Introductory Physiology	Students who have passed BIOL 472 may not schedule this course.
BIOL	142	1	Physiology laboratory	Prerequisite or concurrent BIOL 141
BIOTC (MICRB)	416	2	Microbial biotechnology	Prerequisite MICRB 201, MICRB 202; B M B 442 or MICRB 442
BIOTC (AGRO)	460	3	Advances and applications of plant biotechnology	BIOL 230W, B M B 251

BIOTC	479	3	Methods in biofermentations	Prerequisite: MICRB 201, MICRB 202; BMB 251, BMB 252, BMB 442
B A	250	3	Small business management	3 credits in economics
B LAW	243	3	Legal environment of business	3rd semester standing
CHEM	450	3	Physical chemistry - thermodynamics	CHEM 112, MATH 141; PHYS 211 or 212
CHEM	452	3	Physical chemistry – quantum chemistry	CHEM 112, MATH 141; PHYS 211 or 212
CMPSC	101	3	Introduction to C++ programming	A student may receive credit for only one of the following courses: CMPSC 101, 201C, 201F, CSE 103. Prerequisite: 2 entrance units in mathematics
E R M	210	3	Environmental factors and their effect on your food supply	
E R M	431	3	Environmental toxicology	BIOL 110, CHEM 110, CHEM 112
FIN	100	3	Introduction to finance	Not available to students who have taken BA 301 or FIN 301; 3rd semester standing
FD SC (ANSC)	207	2	Animal products technology	
FD SC (ANSC)	208	1	Animal products technology laboratory	Prerequisite or concurrent FD SC (AN SC) 207
FD SC	404	3	Sensory evaluation of foods	STAT 250 or STAT 240
FD SC	407	2	Food toxins	Senior standing in food science or related majors
FD SC	495	1-18	Internship	Prior approval of proposed assignment by instructor
FD SC	496	1-18	Independent studies	
FD SC	497	1-9	Special topics	
HIST (NUTR, STS)	230	3	American food system: history/technology and culture	
HORT	101	3	Horticultural science	
HORT	412W	3	Post-harvest physiology	6 credits in horticulture or other plant sciences
IST	210	4	Organization of data	IST 110
I B	403	3	International business and national policies	ACCTG 211, B A 301, or FIN 301
MGMT	100	3	Survey of management	Not available to students who have taken B A 304 or MGMT 301
MKTG	220	3	Introduction to selling techniques	Third semester standing
MKTG	221	3	Contemporary American marketing	3 credits in economics –not available to students who have taken BA 303 or MKTG 301
MKTG	301	3	Principles of marketing	ENGL 015, MATH 21; ECON 002 or 004
MKTG	342	3	Marketing research	B A 303 or MKTG 301; SCM 200, or STAT 200
MATH	111	2	Techniques of calculus II	MATH 110
MATH	141	4	Calculus with analytic geometry II	MATH 140, MATH 140A, MATH 140B, or MATH 140H
MICRB	251	3	Molecular and Cell Biology I	CHEM 112
MICRB (BMB)	252	3	Molecular and cell biology II	MICRB 251
MICRB	401	3	Microbial physiology and structure	CHEM 202 or CHEM 210; MICRB 201, MICRB 202
MICRB	410	3	Principles of immunology	B M B 251; MICRB 201 or MICRB

				251
MICRB	412	3	Medical microbiology	MICRB 201
MICRB	413	2	Microbial diversity	MICRB 201, MICRB 202
MICRB	415	3	General virology: bacterial and animal viruses	B M B 251, B M B 252 or BIOL 110, BIOL 230W; MICRB 201
MICRB (BIOTC)	416	2	Microbial biotechnology	MICRB 201, MICRB 202; B M B 442 or MICRB 442
MICRB	421W	3	Laboratory of general and applied microbiology	MICRB 201, MICRB 202
MICRB	422	2	Medical microbiology laboratory	Prerequisite MICRB 202, concurrent MICRB 412
NUTR	120	3	Food preparation	CHEM 202
NUTR (HIST, STS)	230	3	American food system: history/technology and culture	
NUTR (US, IL)	421	3	Food culture and health trends	NUTR 119 or NUTR 120; NUTR 151 or NUTR 251
NUTR (S T S) (IL)	430	3	Global food strategies; problems and prospects for reducing world hunger	
NUTR	451	3	Nutrition throughout the life cycle	NUTR 358, NUTR 445; prerequisite or concurrent NUTR 446
NUTR	452	3	Nutritional aspects of disease	NUTR 446
PL SC (STS)	460	3	Science, technology, and public policy	3 credits in Natural Sciences or Engineering, 3 credits in Social and Behavioral Sciences
R SOC (AGECO)	134	3	Sustainable agriculture science and policy	
STS (NUTR, (HIST)	230	3	American food System: history/technology and culture	
S T S (NUTR) (IL)	430	3	Global food strategies; problems and prospects for reducing world hunger	
STS (PL SC)	460	3	Science, technology, and public policy	3 credits in Natural Sciences or Engineering, three credits in Social and Behavioral Sciences
VB SC	303	3	Principles of animal disease	MICRB 106 or MICRB 201; prerequisite or concurrent AN SC 301
VB SC	430	3	Principles of toxicology	BIOL 110, BIOL 240W; BMB 211, or BMB 401
VB SC (B M B)	433	3	Molecular and cellular toxicology	B M B 401

The following courses can be taken to fulfill General Education Requirements and have relevance to Food Science.

FD SC 105 – Food, facts, and fads – may be taken to fulfill the GHA (Health and Physical Activity) requirement, but will not be approved as a supporting course.

Department	Course Number	Gen Ed	Credits	Title	Prerequisites
AG BM	101	GS	3	Economic principles of agribusiness decision making	
AG	160	GH	3	Introduction into ethics and issues in agriculture	
ECON	315	GS	3	Labor economics	ECON 002
ECON	333	GS	3	International economics	ECON 002, ECON 004, or ECON 014
FD SC (PHIL)	280H	GH	3	Food, values and health	
INTAG	100	GS, IL	3	Introduction to international agriculture	
I B	303	IL	3	International business operations	5th semester standing
IST	110	GS	4	Information, people and technology	
L ER	100	GS	3	Employment relations	
NUTR	100	GHA	1.5	Contemporary nutrition concerns	Students who have received credit for NUTR 151 or NUTR 251 may not schedule this course
NUTR	251	GHA	3	Introductory principles of nutrition	Students who have passed NUTR 151 may not schedule this course.
PHIL (FD SC)	280H	GH	3	Food, values and health	
STS	100	GH	3	The ascent of humanity	
STS	200	GS	3	Critical issues in science, technology, and society	

Who Are the Faculty Members and What Are Their Research Interests?

John D. Floros, Ph.D. (Georgia) Head and Professor of Food Science.
Research in Food Process Engineering and Packaging: Mass transfer in food processing and packaging; process, product and package optimization; alternative processes for improving food safety of minimally processed foods; active packaging; aseptic packaging; package testing; fruit and vegetable processing.
E-mail address: jdf10@psu.edu

Ramaswamy C. Anantheswaran, Ph.D. (Cornell) Professor of Food Science. Microwave processing of foods; Dielectric properties of food materials; Ingredient interactions during microwave heating of foods; Moisture and fat migration in confectionery products; Modified atmosphere and modified humidity packaging of fresh produce; Rapid cooling of shell eggs. E-mail address: rca3@psu.edu

J. Lynne Brown, Ph.D. (Massachusetts Institute of Technology) Professor of Food Science.
Understanding consumer perception of risk associated with food ingredients and food production practices; building a model of how food choices are negotiated in different types of families over the family life cycle. Evaluation of the impact of educational programs on behavior.
E-mail address: f9a@psu.edu

John Coupland, Ph.D. (University of Leeds) Professor of Food Science. Physical chemistry of foods. Food emulsions and biopolymers and their behavior during processing. Ultrasonic sensors. E-mail address: jnc3@psu.edu

Catherine N. Cutter, Ph.D. (Clemson) Associate Professor of Food Science.
Processing and manufacturing of muscle foods with an emphasis on food safety; pathogen reduction, application of antimicrobials or interventions to muscle foods; understanding the mechanisms of bacterial attachment to muscle foods.
E-mail address: cnc3@psu.edu

Stephanie Doores, Ph.D. (Maryland) Associate Professor of Food Science. Growth and survival of *Listeria monocytogenes* in food, particularly dairy and meat products; predicting the thermal kinetics and destructive force of microwave heating on food-borne pathogens; characterization of *Sporolactobacillus* and other *Bacillus-Lactobacillus* intermediates. E-mail address: sxd11@psu.edu

Edward G. Dudley, Ph.D. (Wisconsin) Assistant Professor of Food Science. Molecular biology and genomics of foodborne pathogens. Mechanisms of environmental survival and pathogenicity of *Escherichia coli* O157:H7 and enteroaggregative *Escherichia coli*. Molecular biology methods of detecting and characterizing bacteria in food. Email address: egd100@psu.edu

Ryan J. Elias, Ph.D. (Massachusetts) Assistant Professor of Food Science.
Free radical chemistry of foods: Metal-catalyzed lipid and protein oxidation in complex foods; development and evaluation of novel antioxidants; oxidative stability of wine and beer. E-mail address: rje12@psu.edu

Hassan Gourama, Ph.D. (Nebraska) Associate Professor of Food Science. (Berks Campus).
Significance of molds and mycotoxins in foods: Identification of molds, mold growth and mycotoxin production, control of mold contaminants and development of rapid detection methods for molds. Occurrence and control of bacterial pathogens in foods. E-mail address: hxg7@psu.edu

John Hayes, Ph.D. (University of Connecticut) Assistant Professor of Food Science.
Flavor perception, behavioral genetics and food choice; impact of genetic variation on sensation and reward; understanding factors that influence consumption of food or beverages with potential health impact; acquisition of preference for initially aversive stimuli (chiles, coffee, alcohol). E-mail address: jeh40@psu.edu

Stephen J. Knabel, Ph.D. (Iowa State) Professor of Food Science. Recovery and detection of injured foodborne pathogens; heat resistance of *Listeria monocytogenes;* control of food-borne pathogens; biological function of heat-shock proteins and their role in thermotolerance; microbiology of poultry, eggs, dairy products, fish, red meats and mushrooms. E-mail address: sjk9@psu.edu

Luke LaBorde, Ph.D. (Wisconsin) Associate Professor of Food Science. Quality and safety of minimally processed and shelf-stable fruits and vegetables. Development of food safety extension programs for fruit, vegetable, and mushroom producers. E-mail address: lfl5@psu.edu

Joshua D. Lambert, Ph.D. (Arizona) Assistant Professor of Food Science. Prevention of obesity, fatty liver disease, and cancer by dietary phytochemicals. Potential toxicities of high dose dietary polyphenols. Bioavailability and biotransformation of dietary phytochemicals. Email address: jdl134@psu.edu

Edward Mills, Ph.D. (Purdue) Associate Professor of Dairy and Animal Science. Meat composition and processing with emphasis on prerigor processing techniques. E-mail: ewm3@psu.edu

Robert F. Roberts, Ph.D. (Minnesota) Associate Professor of Food Science. Technology of dairy products processing. E-mail address: rfr3@psu.edu

Donald B. Thompson, Ph.D. (Illinois) Professor of Food Science. Food chemistry, with emphasis on starch molecular structure and granule function; nutrition, with emphasis on the effect of processing on nutrient bioavailability. E-mail address: dbt1@psu.edu

Gregory R. Ziegler, Ph.D. (Cornell) Professor of Food Science. Foods as composite materials. Physical properties and processing of polymeric and particulate foods, with an emphasis on chocolate and confectionery products. E-mail address: grz1@psu.edu

For more information, please see our web page at: http://www.foodscience.psu.edu

What Facilities Are Available For The Teaching of Food Science?

Food Processing and Pilot Facilities

Pilot plants are available and equipped for processing of many types of foods, in particular dairy products, fruits, vegetables, mushrooms, chocolate and table wines. The Sensory Evaluation Lab includes a fully equipped kitchen and 12 testing booths.

Processing facilities for poultry consist of killing, picking, eviscerating, chilling and freezing equipment. Product development and quality control facilities are also included in this area. Federally inspected slaughter and red meat processing facilities are available to handle 20 head of cattle or 40 hogs daily and include holding pens, killing floor, refrigerated storage, cutting and processing areas, and an automated smokehouse.

The Berkey Creamery processes more than 4.5 million pounds of milk annually for the manufacture of beverage milks, frozen desserts, cheese and other processed products. The Creamery serves as a site for class projects, research and extension programs in food processing.

Research Facilities

Over twenty laboratories are available for the instruction, research, and graduate programs of the Department of Food Science. These laboratories are specifically designated and/or equipped for the study of food engineering, biotechnology, sensory evaluation, managing quality, food contaminants, food chemistry and food microbiology.

Major research equipment available includes a differential scanning calorimeter, viscometer, supercritical fluid extractor, gas- and high-pressure liquid chromatographic apparatus, spectrophotometers, color difference meters, scanning electron-, phase-contrast-, light- and fluorescence microscopes, refrigerated ultra-centrifuge, electrophoresis and electrofocusing equipment, shear presses, cryostats and continuous and batch fermentation systems.

Is There A Student Club For Food Science Majors At Penn State?

The Penn State Food Science Club was organized in 1973 to promote leadership and interest in Food Science as a profession and to foster a closer relationship among Food Science undergraduate students, graduate students and faculty. The club is also open to those students outside of the Food Science major who wish to learn more about activities in this field. The club is an affiliated student chapter of the Institute of Food Technologists (IFT), the professional association.

The Food Science Club sponsors speakers from industry, government, and academia to acquaint students with all aspects of the field. Other activities include discussion sessions between students and Food Science faculty members, departmental delegations to Institute of Food Technologists' national and regional meetings, and other IFT-related student events. The activities in which club members are engaged include student-faculty picnics and fund-raising projects.

What Financial Aid Is Available To Food Science Majors?

Various sources of financial aid are available to Penn State students, whether they are enrolled at University Park or at a campus. This financial aid includes federally funded grants, loans and work-study support, such as Pell Grants, National Defense Student Loans (NDSL) and the College Work Study Program (CWSP). In addition, state-funded grants and loans can be obtained through the Pennsylvania Higher Education Assistance Agency (PHEAA), as well as through the University. Detailed information on financial aid can be found in the Office of Student Aid, 314 Shields Building, or on the Office of Student Aid website: http://www.psu.edu/dept/studentaid/. Financial Assistance for Students in Agriculture describes specific financial aid available to students in the College of Agriculture and information can be accessed at the College's website, http://students.cas.psu.edu/scholarships.htm. Some of this aid is in the form of scholarships administered by the Food Science Department.

In addition, a limited number of national competitive scholarships sponsored by the Institute of Food Technologists are awarded annually to undergraduates, including entering students, pursuing a Bachelor of Science degree in Food Science. This information can be accessed at http://www.ift.org/knowledge-center/learn-about-food-science/become-a-food-scientist/scholarships.aspx. Further information on these scholarships can be obtained by writing to the Department of Food Science, 202 Food Science Building, University Park, PA 16802. This should be done no later than December 15th of the year preceding the academic year in which enrollment is planned.

Note that to be eligible for need-based sources of College and Departmental financial support, a FAFSA (Free Application for Federal Student Aid) form **must be on file** with the University. Pennsylvania residents should complete the PHEAA form, and out-of-state residents should complete the FAF form. Both forms are available from the office of student aid.

How Can I Enhance My Food Science Degree?

All students graduate with 128 credits or more, so what makes your record stand out? The following are opportunities to enhance your degree. If any of these opportunities interest you, talk with your advisor for further information.

- Simultaneous Degree (Double Major) – A plan of study meeting the requirements of two majors that combines two distinct fields where a combination of background and depth is desired by the student. Depending on the second major, the credits required for graduation could necessitate additional time before graduation.

- Minor – A supplemental academic program of at least 18 credits. Students should explore the requirements of the proposed minor, then meet with an advisor from the prospective program that would award the minor. The following minor programs may be of interest to Food Science students:

College of Agricultural Sciences
- Agribusiness Management
- Agricultural and Biological Engineering
- Agricultural Communications
- Agricultural Economics and Rural Sociology
- Animal Sciences
- Horticulture
- International Agriculture
- Leadership Development
- Mushroom Science and Technology
- Plant Pathology
- Poultry and Avian Science
- Spanish

College of Earth and Mineral Sciences
- Polymer Science

College of Engineering
- Agricultural and Biological Engineering
- Bioengineering
- Engineering Leadership Development

College of Health and Human Development
- Nutritional Sciences

College of the Liberal Arts
- Business/Liberal Arts

Eberly College of Science
- Biochemistry and Molecular Biology
- Biology
- Chemistry
- Microbiology

Independent Research – Subject to agreement by a faculty member, research can be conducted in an area of food science of interest to the student, and students can earn credit through FD SC 496 for this activity. Students should speak with an individual faculty member to determine the feasibility of a project, including scope and length of the project, the number of credits that would be appropriate, and what would be expected. Competitive funding for research can be sought through the Department of Food Science (Mark & Nancy Speizer Undergraduate Research Endowment in Food Science). The College of Agricultural Sciences also offers funding for research projects (Undergraduate Student Research Award).

- Co-op Experience and Summer Internships for academic credit (FD SC 495) – Students who are interested in obtaining industry experience in addition to their academic program can enroll in either a coop experience for academic credit or a summer internship experience with academic credit. Generally, a coop program is 6-8 months in length and spans a spring-summer or summer-fall period. This opportunity provides a more in-depth exposure for the student than a summer internship. Students wishing to enroll in FDSC 495 should first consult with Dr. Stephanie Doores **three months prior to the start of the internship**.

- Summer Internships (not for academic credit) – Students are strongly encouraged to gain experience during at least one summer with a food or food-related business, laboratory or regulatory agency. Such experiences offer insight into typical jobs a student might encounter in the field. The majority of food science students take a summer internship job between their third and fourth year.

- Study Abroad – Students are often interested in spending a semester abroad. Although the department does not have any formal agreements with foreign institutions, the College and University do. In addition, shorter length international programs are available during spring break and summers. Anyone interested in a study abroad experience should speak with his or her advisor or, Ms. Ketja Lingenfelter, Study Abroad Coordinator, 122 Agricultural Administration Building.

- Spanish for Students in the Field of Agricultural Sciences is a three-course sequence developed for students whose future involves working in management positions in agricultural industries such as mushroom production, landscaping, dairy, animal sciences, poultry, horticulture, food science, and forestry, to name a few. The program includes a three-week immersion experience at the end of spring semester. During the immersion experience, students live with Mexican families while they study and experience the language, culture, and agricultural industries of Mexico. Students should begin this program early so that they can travel to Mexico before their junior year when they might want to engage in an internship

- Student Paper Competitions – Students have the opportunity to present their research results at the College and/or University Undergraduate Research Exposition(s) held in the spring semester. The Institute of Food Technologist also holds a Student Association Undergraduate Research Paper Competition at its annual meeting.

How Can I Learn More About The Major?

For further information about the Food Science Major write to:

Dr. Stephanie Doores
Undergraduate Program Coordinator
432 Food Science Building
University Park, PA 16802
(814) 863-2956
E-mail: sxd11@psu.edu

Or visit our World Wide Web page at:

http://www.foodscience.psu.edu

For information on **Penn State Admissions** procedures write to:

Director of Admissions
The Pennsylvania State University
201 Shields Building
University Park, PA 16802

Or visit the **Penn State Admissions** web site at:

http://.admissions.psu.edu