

FOOD SCIENCE

Graduate Program Head	Robert F. Roberts
Program Code	FDSC
Campus(es)	University Park (Ph.D., M.S.)
Degrees Conferred	Doctor of Philosophy (Ph.D.) Master of Science (M.S.) Dual-Title Ph.D. in Food Science and Clinical and Translational Science Dual-Title Ph.D. and M.S. in Food Science and International Agriculture and Development Dual-Title Ph.D. in Food Science and Microbiome Sciences
The Graduate Faculty	View (https:// secure.gradsch.psu.edu/gpms/? searchType=fac&prog=FDSC)

Graduate work leading to the M.S. and Ph.D. degrees in Food Science is directed toward a multidisciplinary and integrated approach to teaching and research relevant to processing and manufacture of value-added foods from agricultural commodities. Through integration of the disciplines of chemistry, microbiology, engineering, and nutrition, students learn to ensure that consumers can make healthful choices from an abundant supply of affordable, safe, nutritious, and appealing foods.

Admission Requirements

Applicants apply for admission to the program via the J. Jeffrey and Ann Marie Fox Graduate School application for admission (<https://gradschool.psu.edu/admissions/how-to-apply/>). Requirements listed here are in addition to Graduate Council policies listed under GCAC-300 Admissions Policies (<https://gradschool.psu.edu/graduate-education-policies/>).

Students with a 3.00 junior/senior average (on a 4.00 scale) will be considered for admission to the program. Exceptions may be made at the discretion of the program.

Best preparation for graduate work in Food Science is the completion of an undergraduate degree in food science, biochemistry, chemistry, chemical engineering, microbiology, or other related areas. The undergraduate program must include calculus, organic chemistry, microbiology, and general physics. Students may be provisionally admitted (<http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-300/provisional-admission/>) with deficiencies but are required to make them up without degree credit. GRE scores will not be accepted.

Students are generally admitted directly to a master's program unless they have previously earned an M.S. degree in food science or an appropriate related area.

Degree Requirements

Master of Science (M.S.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (<https://gradschool.psu.edu/graduate-education-policies/>)

A minimum of 30 credits at the 400, 500, 600 or 800 level is required, with at least 18 credits in the 500 and 600 series, combined. There are 24 credits required in the following core courses:

Code	Title	Credits
Required Courses		
FDSC 500A	Fundamentals of Food Science - Microbiology	1
FDSC 500B	Fundamentals of Food Science - Engineering	1
FDSC 500C	Fundamentals of Food Science - Chemistry	1
FDSC 500D	Fundamentals of Food Science - Nutrition	1
FDSC 501	Research Methods in Food Science	2
6 credits of other 500-level FDSC courses (3 credits of the requirement can be satisfied by 400-level Food Science courses with permission of the adviser.)		6
6 credits of 400- or 500-level courses - must include Statistics (STAT 500 or equivalent)		6
Electives		
The remaining 6 credits may be chosen from a list of approved electives maintained by the program office.		6
Culminating Experience		
FDSC 600	Thesis Research	6
Total Credits		30

In addition, M.S. students are required to complete 1 credit of FDSC 602: Supervised Experience in College Teaching prior to the TA experience; however, this 1 credit cannot be counted towards the minimum 30 credits required.

The M.S. degree also requires the formation of a master's committee, the writing of a satisfactory thesis accepted by the master's committee, the head of the graduate program, and the Graduate School, and the passing of a final oral examination.

International students must also take the American English Oral Communicative Proficiency Test (AEOCPT).

Doctor of Philosophy (Ph.D.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (<https://gradschool.psu.edu/graduate-education-policies/>)

A minimum of 12 credits is required for the Ph.D. degree; Ph.D. students who did not complete an M.S. in Food Science or related field must complete 12 additional credits, for a minimum of 24 credits:

Code	Title	Credits
Required Courses		
FDSC 500A	Fundamentals of Food Science - Microbiology ¹	1
FDSC 500B	Fundamentals of Food Science - Engineering ¹	1
FDSC 500C	Fundamentals of Food Science - Chemistry ¹	1
FDSC 500D	Fundamentals of Food Science - Nutrition ¹	1
FDSC 501	Research Methods in Food Science ¹	2
6 credits of other 500-level FDSC courses (3 credits of the requirement can be satisfied by 400 level Food Science courses with permission of the adviser.)		6

Students must have satisfactorily completed at least one 400 or 500-level course in statistics (i.e., STAT 500 Applied Statistics or equivalent), during their undergraduate or graduate program

Total Credits**12**

¹ Not needed if student received credit for these courses during master's degree program at Penn State.

In addition, Ph.D. students are required to complete 1 credit of FDSC 602: Supervised Experience in College Teaching prior to the TA experience; however, this 1 credit cannot be counted towards the minimum credits required for the degree.

Except in special cases, an M.S. in Food Science is earned before pursuing a Ph.D. degree. Although most applicants to the Ph.D. program have already obtained a master's degree in Food Science or a related program, the M.S. degree is not a prerequisite for entrance into the doctoral program. For students entering the Ph.D. program without having earned an M.S. degree in Food Science or related field, 12 additional credits are required:

- FDSC 600, 6 credits
- Additional 400 or 500-level FDSC courses, 6 credits

All doctoral students must pass a qualifying examination, a comprehensive written and oral examination, and a final oral examination (the dissertation defense). To earn the Ph.D. degree, doctoral students must also write a dissertation that is accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School. In addition, all Food Science Ph.D. candidates are assessed for English competency. International students must also take the American English Oral Communicative Proficiency Test (AEOCPT).

Dual-Titles

Dual-Title Ph.D. in Food Science and Clinical and Translational Sciences

Requirements listed here are in addition to requirements listed in GCAC-208 Dual-Title Graduate Degree Programs (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-208-dual-titles/>).

Students must apply and be admitted to the graduate program in Food Science and the Graduate School before they can apply for admission to the dual-title degree program. After admission to their primary program, students must apply for admission to and meet the admissions requirements of the CTS dual-title program. Refer to the Admission Requirements section of the CTS Bulletin page (<http://bulletins.psu.edu/graduate/programs/majors/clinical-translational-sciences/>). Doctoral students must be admitted into the dual-title degree program in CTS prior to taking the qualifying examination in their primary graduate program.

An admissions committee comprised of faculty affiliated with the dual-title program will evaluate applicants. Applicants must have a graduate GPA of at least 3.5. Prospective dual-title program students must include in their application a statement of purpose that addresses the ways in which their research and professional goals will be enhanced by an interdisciplinary course of study in clinical and translational sciences.

The Dual-Title Ph.D. in Food Science and Clinical and Translational Sciences emphasizes interdisciplinary scholarship at the interface of basic sciences, clinical sciences, and human health. Students in the dual-

title program are required to have two advisers from separate disciplines: one individual serving as the primary mentor from the Graduate Program in Food Science and another individual serving as the secondary mentor from an area covered by the dual-title program who is a member of the Clinical and Translational Sciences faculty.

Degree Requirements

To qualify for the dual-title degree in Food Science and Clinical and Translational Sciences, students must satisfy the Food Science Ph.D. degree requirements listed in the Degree Requirements section. In addition, students must complete the degree requirements for the dual-title CTS, listed on the CTS Bulletin page (<http://bulletins.psu.edu/graduate/programs/majors/clinical-translational-sciences/>). Approximately 6 credits of course work may overlap with elective courses required by the Ph.D. program in Food Science.

For students in the dual-title program, the qualifying examination consists of the standard Food Science qualifying exam with one modification. A member of the CTS Graduate Faculty will join the standing FDSC qualifying examination committee during the normal FDSC exam and assess the student's CTS knowledge. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. This occurs by assigning the student a paper that has clinical relevance, or by asking the student questions that require him or her to extend the assigned paper into a clinical/translational context. This examination must be completed before the end of the second year, within four semesters (summer sessions do not count) of entry into the doctoral program.

The student's Ph.D. committee will include Graduate Faculty from Food Science and Graduate Faculty from Clinical and Translational Science. In addition to the general Graduate Council requirements for Ph.D. committees (<http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/phd-dissertation-committee-formation/>), the Ph.D. committee of a Food Science and CTS dual-title doctoral degree student must include at least one member of the CTS Graduate Faculty. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. If the chair of the Ph.D. committee representing Food Science is not also a member of the Graduate Faculty in CTS, the member of the committee representing CTS must be appointed as co-chair.

The fields of food science and clinical and translational sciences will be integrated in the student's comprehensive examination. The CTS representative on the student's Ph.D. committee will develop questions for and participate in the evaluation of the comprehensive examination.

All dual-title students are required to conduct dissertation research that contributes fundamentally to the fields of food science and clinical and translational sciences. Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. The dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.

Dual-Title M.S. and Ph.D. in Food Science and International Agriculture and Development

Requirements listed here are in addition to requirements listed in GCAC-208 Dual-Title Graduate Degree Programs (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-208-dual-titles/>).

Graduate students with research and educational interests in international agriculture and development may apply to the dual-title

degree program in Food Science and INTAD. The goal of the dual-title degree program in Food Science and INTAD is to enable graduate students from Food Science to acquire the knowledge and skills of their primary area of specialization in Food Science, while at the same time gaining the perspective and methods needed for work in international agriculture. Graduate study in this program seeks to prepare students to assume leadership roles in science, science education, outreach, and project management anywhere in the world. Students are required to write research proposals and expected to write grants to support their research activities, reflecting the dual-title degree. As part of their professional development presentations, publication of research articles and active participation in professional societies is expected. Emphasis is placed upon the professional development of the student. Students can specialize in the research program areas of:

- food chemistry,
- food microbiology,
- food engineering,
- effects of processes on nutrition,
- sensory science,
- bioactive components,
- human gut microbiome,
- food processing, and
- extension education.

INTAD students will acquire a broad perspective on how to apply their research findings in the context of the broader international community. Thus, the dual-title will allow students to master their field of specialization from an international perspective so that they can compare practices and outcomes between countries and regions.

Admission Requirements

For admission to the dual-title graduate degree under this program, a student must first apply and be admitted to the Food Science graduate program and the Graduate School. Once accepted into the Food Science program, the student can apply to the INTAD Academic Program Committee for admission to the dual-title degree program. The student must obtain consent from their Food Science adviser prior to applying to the INTAD program. Refer to the Admission Requirements section of the INTAD Bulletin page (<http://bulletins.psu.edu/graduate/programs/majors/international-agriculture-development/>). Ph.D. students must apply and be admitted to the dual-title degree program in International Agriculture and Development prior to taking the qualifying exam.

Degree Requirements for the Dual-Title M.S.

To qualify for this dual-title degree, students must satisfy the requirements of the Food Science Master of Science degree program, described under Degree Requirements. In addition, they must satisfy INTAD program requirements for the dual-title master's degree (<http://bulletins.psu.edu/graduate/programs/majors/international-agriculture-development/>). Some courses may satisfy both Food Science program requirements and those of the INTAD program. Final course selection must be approved by the student's advisory committee.

Degree Requirements for the Dual-Title Ph.D.

To qualify for this dual-title degree, students must satisfy the requirements of the Food Science Ph.D. program, described under Degree Requirements. In addition, they must satisfy INTAD program requirements for the dual-title Ph.D. degree (<http://bulletins.psu.edu/graduate/programs/majors/international-agriculture-development/>). Some courses may satisfy both Food Science program requirements and

those of the INTAD program. Final course selection must be approved by the student's Ph.D. committee.

The Qualifying Examination committee for the dual-title degree will be composed of Graduate Faculty from Food Science and must include at least one Graduate Faculty member from the INTAD program. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. There will be a single qualifying examination, containing elements of both Food Science and INTAD. Dual-title graduate degree students may require an additional semester to fulfill requirements for both areas of study and, therefore, the qualifying examination may be delayed one semester beyond the normal period allowable.

In addition to the general Graduate Council requirements for Ph.D. committees (<http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/phd-dissertation-committee-formation/>), the Ph.D. committee of a dual-title doctoral degree student must include at least one member of the INTAD Graduate Faculty. Faculty members who hold appointments in both programs' Graduate Faculty may serve in a combined role. If the chair of the committee representing Food Science is not also a member of the Graduate Faculty in INTAD, the member of the committee representing INTAD must be appointed as co-chair. The INTAD representative on the student's Ph.D. committee will develop questions for and participate in the evaluation of the comprehensive examination.

Students enrolled in the dual-title program are required to write and orally defend a dissertation on a topic that reflects their original research and education in Food Science and INTAD. Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. The dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.

Dual-Title Ph.D. in Food Science and Microbiome Sciences

Requirements listed here are in addition to requirements listed in GCAC-208 Dual-Title Graduate Degree Programs (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-208-dual-titles/>).

Doctoral students with research and educational interests in microbiome sciences may apply to the dual-title degree program in Food Science and Microbiome Sciences. The goal of the dual-title Ph.D. degree in Food Science and Microbiome Sciences is to enable graduate students from Food Science to acquire the knowledge and skills of their major area of specialization in Food Science, while at the same time gaining expertise and skills in Microbiome Sciences. Graduate study in this program seeks to provide students with the intellectual foundation for integrated and mechanistic understanding of interactions between food and microbes in the contexts of food processing, food safety and human health. Interdisciplinary training that includes Microbiome Sciences will prepare students for positions in academia, government, non-profit organizations, and the private sector, where skills in microbiome analysis are increasingly in demand.

Admission Requirements

For admission to the dual-title doctoral degree in Microbiome Sciences, a student must first apply and be admitted to the Food Science PhD graduate program and The Graduate School. Once accepted into the Food Science program, the student must then apply to and meet the admissions requirements of the Microbiome Sciences dual-title program. Refer to the Admission Requirements section of the Microbiome

Sciences Bulletin page. Ph.D. students may be admitted into the dual-title degree program in Microbiome Sciences at any time prior to the end of their fourth semester (not counting summer semesters).

Degree Requirements

To qualify for the dual-title degree, students must satisfy the Food Science Ph.D. degree requirements. In addition, students pursuing the dual-title Ph.D. in Food Science and Microbiome Sciences must complete the degree requirements for the dual-title Microbiome Sciences Ph.D., listed on the Microbiome Sciences Bulletin page. In accordance with the general Graduate Council requirements for Ph.D. committees, the Ph.D. committee of a Food Science and Microbiome Sciences dual-title doctoral degree student must include at least one member of the Microbiome Sciences Graduate Faculty. Faculty members who hold appointments in both the Food Science Graduate Faculty and the Microbiome Sciences Graduate Faculty may serve in a combined role. If the chair of the Ph.D. committee is not also a member of the Graduate Faculty in Microbiome Sciences, the member of the committee representing Microbiome Sciences must be appointed as co-chair.

All students must pass the qualifying examination in their major field of study. No additional qualifying exam will be required. The Microbiome Sciences representative on the student's Ph.D. committee will develop questions for and participate in the evaluation of the comprehensive examination.

Students enrolled in the dual-title program are required to write and orally defend a dissertation on a topic that reflects their original research and education in Food Science and Microbiome Sciences. Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. The dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.

Minor

A graduate minor is available in any approved graduate major or dual-title program. The default requirements for a graduate minor are stated in Graduate Council policy GCAC-218 Minors (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200/gcac-218-minors/>).

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the Tuition & Funding (<https://gradschool.psu.edu/funding/>) section of the J. Jeffrey and Ann Marie Fox Graduate School's website. Students on graduate assistantships must adhere to the course load limits (<https://gradschool.psu.edu/graduate-education-policies/gsad/gsad-900/gsad-901-graduate-assistants/>) set by the Fox Graduate School.

Courses

Graduate courses carry numbers from 500 to 699 and 800 to 899. Advanced undergraduate courses numbered between 400 and 499 may be used to meet some graduate degree requirements when taken by graduate students. Courses below the 400 level may not. A graduate student may register for or audit these courses in order to make up deficiencies or to fill in gaps in previous education but not to meet requirements for an advanced degree.

Food Science (FDSC) Course List (<https://bulletins.psu.edu/university-course-descriptions/graduate/fdsc/>)

Learning Outcomes

Master of Science (M.S.)

1. **KNOW:** Graduates will develop a deep conceptual understanding of food chemistry, microbiology, engineering, nutrition.
2. **THINK:** Graduates will be able to solve practical problems in the Food Science field.
3. **APPLY/CREATE:** Graduates will demonstrate the ability to design scientific approaches to solve practical problems and to select appropriate methods of data analysis.
4. **COMMUNICATE:** Graduates will be able to accurately report the results of research data in field of food science through written and oral presentations.
5. **PROFESSIONAL PRACTICE:** Graduates will conduct themselves in an ethical and professional manner.

Doctor of Philosophy (Ph.D.)

1. **KNOW:** Graduates will develop a deep conceptual understanding of food chemistry, microbiology, engineering, nutrition and apply that understanding to critically evaluate the state-of-the-science.
2. **THINK:** Graduates will be able to evaluate existing knowledge to independently identify and define original research problems.
3. **APPLY/CREATE:** Graduates will demonstrate the ability to design scientific approaches to solve novel questions, to select appropriate methods of data analysis, and to synthesize the resultant data to develop informative conclusions and subsequent research directions.
4. **COMMUNICATE:** Graduates will be able to create research plans, approaches and underlying rationale and report the results of their research data in field of food science through peer-reviewed written and oral presentations.
5. **PROFESSIONAL PRACTICE:** Graduates will conduct themselves in an ethical and professional manner.

Contact

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