College of Tropical Agriculture and Human Resources

Administration

Gilmore Hall 202
3050 Maile Way
Honolulu, HI 96822
Tel: (808) 956-8234
Fax: (808) 956-9105
Web: www.ctahr.hawaii.edu

Interim Dean: Sylvia Yuen
Associate Dean: Charles M. Kinoshita
Interim Associate Dean: Kenneth Grace
Interim Associate Dean: Carl I. Evensen

General Information

The College of Tropical Agriculture and Human Resources (CTAHR) was established with the founding of UH in 1907. CTAHR is a leading academic institution in tropical agriculture, biological engineering, food science and human nutrition, apparel design and merchandising, biotechnology, natural resources and environmental management, and family resources. Hawai'i's unique geographic location, ecological diversity, and multicultural population provide students with a living laboratory. The college is the locus of educational opportunities for students preparing to become tomorrow's scientists, technologists, business leaders, family development specialists, fashion designers and merchandisers, nutritionists, and policy makers.

The land-grant mission of CTAHR provides students with an opportunity to study in an environment that blends teaching, research, and extension programs dedicated to discovering the secrets of basic science while addressing contemporary issues. Faculty members bring to the classroom the unique perspective of emerging research issues, coupled with an abiding commitment to education.

Through its extension activities, the college provides off-campus, noncredit educational programs focused on the advancement of agriculture in Hawai'i, protection of the environment, and the strengthening of families and communities.

Through its research activities, the college promotes the advancement of life sciences and applications for productive sustainable agriculture. Investigations cover plant and animal physiology; plant, insect, microbial, aquacultural, bioreactor and environmental biotechnology; diseases, insects, and parasites; agronomy; soils; food science; food processing; environmental management; biological engineering; bioremediation; biochemistry; human and animal nutrition; breeding and genetics; and culture, production, economics, marketing, and quality of life for individuals and families.

CTAHR Program Goals:

To prepare its students for success, CTAHR's programs focus on four goals that incorporate characteristics desired by prospective employers. Each CTAHR graduate should be able to:

- Communicate appropriately and clearly in a variety of oral and written forms to both professional and non-technical audiences.
- Apply analytical, problem-solving, business management, and technological skills to everyday and discipline-related challenges.
- Develop positive and ethical personal characteristics and appropriate interpersonal and leadership skills.
- Gain a broad understanding of real-world experiences and global issues through the exploration of and involvement in career-related opportunities.

Degrees and Certificates Offered

Certificates: Graduate Resource Management Certificate, Agribusiness Management Certificate

Bachelor's Degrees: BS in animal sciences, BS in apparel product design and merchandising, BS in biological engineering, BS in family resources, BS in food science and human nutrition, BS in natural resources and environmental

Contents

management, BS in plant and environmental biotechnology, BS in plant and environmental protection sciences, BS in tropical plant and soil sciences

Master's Degrees: MS in biological engineering, MS in entomology, MS in food science, MS in animal sciences, MS in molecular biosciences and bioengineering, MS in natural resources and environmental management, MS in nutritional sciences, MS in tropical plant pathology, MS in tropical plant and soil sciences

Doctoral Degrees: PhD in entomology, PhD in molecular biosciences and bioengineering, PhD in natural resources and environmental management, PhD in nutrition, PhD in tropical plant pathology, PhD in tropical plant and soil sciences

Advising

CTAHR Office of Academic and Student Affairs
Gilmore 210
3050 Maile Way
Honolulu, HI 96822
Tel: (808) 956-8183 or (808) 956-6733
Fax: (808) 956-3706
Email: acadaff@ctahr.hawaii.edu
Web: www.ctahr.hawaii.edu

Undergraduate Programs

Undergraduate programs in CTAHR provide students with an opportunity to acquire those scientific, professional, and personal competencies emphasized by Hawai'i's business, governmental, community, and scientific leaders. The college provides a balance of educational experiences that include classroom instruction, laboratory sessions, co-curricular activities, supervised internships, and international study. Student exchange programs are also available for those desiring short term exposure to other institutions.

Admission Requirements

Students may enter CTAHR as freshmen or as transfer students from other departments or academic institutions. Requirements for admission are the same as those for the UH Mānoa campus in general, except for the food science and human nutrition, family resources, apparel product design and merchandising, and natural resources and environmental management majors. Transfer students are required to have a minimum GPA of 2.5 for apparel product design and merchandising, and natural resources and environmental management majors, 2.6 for family resources majors

Incoming freshmen, transfer student from other majors, and transfer students from other institutions with interest in the Food Science and Human Nutrition (FSHN) major are classified as "pre-FSHN," and required to have a minimum GPA of 2.8. Information on CTAHR undergraduate programs can be obtained from the CTAHR Office of Academic and Student Affairs.

College Requirements

To be eligible for a BS degree from CTAHR, students must complete the General Education Core requirements, CTAHR requirements, course requirements of the CTAHR major, and at least 60 credit hours of non-introductory courses (i.e., those numbered 300 and above or having a college-level prerequisite), earn a minimum cumulative 2.0 GPA in major courses, and maintain a minimum cumulative GPA of 2.0 in a minimum of 126-128 credit hours as prescribed by the major. Some majors may require more credit hours. All CTAHR undergraduates are required to complete a set of interrelated courses: Speech course or equivalent; FAMR 380/380L Research Methodology/Lab or NREM 310 Statistics in Agriculture and Human Resources; and an internship or capstone course within their major field. Foreign language requirements are specific to each academic program. Check with the departmental advisor for more information.

Double Major or Second Degree

Students seeking a double major must have a minimum cumulative GPA of 3.2, demonstrate that the proposed majors are substantially different, and obtain approval from undergraduate advisors in both of the relevant programs.

Students seeking a second degree must have a minimum cumulative GPA of 3.0 and demonstrate that the proposed second degree is substantially different from the first degree. At least 30 credit hours are required for the second degree in addition to those associated with the first degree.

Concurrent Degree

It is the policy of CTAHR to allow CTAHR students and non-CTAHR students to earn undergraduate concurrent degrees in two separate programs. Students applying for an undergraduate concurrent degree in CTAHR must have earned at least 24 credits and have a UH Mānoa minimum cumulative GPA of 3.25. Students also need to meet other requirements for the concurrent degree.

Related Undergraduate Programs

Agriculture Education

Students who wish to teach agriculture at the secondary level in Hawai'i can meet the state Department of Education's requirements by taking courses from CTAHR and the College of Education. Students may obtain a BS degree in CTAHR prior to transferring to the post-baccalaureate basic certification program in the College of Education. Other students transfer to CTAHR from other programs in the UH System and take courses from CTAHR and the College of Education. Additional information can be obtained from the CTAHR Office of Academic and Student Affairs or the College of Education Student Services Office, Wist Annex 2-126, (808) 956-7849.

Home Economics Education

Students planning on teaching home economics at the secondary level generally begin in CTAHR's Department of Family and Consumer Sciences and then transfer to the College of Education in their junior year. Course work is taken in CTAHR's Department of Family and Consumer Sciences, Department of Human Nutrition, Food, and Animal Sciences, and the College of Education. Additional information can be obtained from the Department of Family and Consumer Sciences, Miller 110, (808) 956-8105 or College of Education Student Services Office, Wist Annex 2-126, (808) 956-7849.

Graduate Programs

Graduate studies leading to a master of science degree are available in nine fields: animal sciences; biological engineering; entomology; food sciences; molecular biosciences and biological engineering; natural resources and environmental management; nutritional science; tropical plant pathology; and tropical plant and soil sciences. Doctor of philosophy programs are available in six fields: tropical plant pathology, molecular biosciences and bioengineering, entomology, natural resources and environmental management, nutrition, and tropical plant and soil sciences.

Three of CTAHR's graduate programs in tropical agriculture (entomology, natural resources and environmental management, and tropical plant and soil sciences), have been recognized as distinctive programs by the Western Interstate Commission for Higher Education (WICHE). Qualified students from participating states may enroll in these graduate programs at Hawai'i-resident tuition rates.

CTAHR utilizes general UH Mānoa facilities, including the libraries, which offer extensive collections and information services, and the computing center, which provides access to individual computers as well as large mainframes. Along with the Pacific Biomedical Research Center, CTAHR sponsors the Biotechnology-Molecular Biology Instrumentation Facility for the benefit of researchers throughout UH Mānoa. The college's facilities include a microcomputer laboratory, several research stations, and specialized laboratories with state-of-the-art equipment, all of which support research and instruction in the food and life sciences. On-campus affiliations with the Hawai'i Institute of Marine Biology, Water Resources Research Center, East-West Center, Harold L. Lyon Arboretum, Sea Grant College Program, and Hawai'i Natural Energy Institute extend CTAHR's resources. The college is also affiliated closely with off-campus institutions, such as the Bernice P. Bishop Museum, USDA/ARS Tropical Fruit and Vegetable Research Laboratory, Hawai'i Agriculture Research Center, U.S. Geological Survey, National Marine Fisheries Service, and Hawai'i Department of Agriculture.

Students may contact individual departments, the Graduate Division, 2540 Maile Way, Spalding Hall, Honolulu, HI 96822, or Financial Aid Services, 2600 Campus Road, Honolulu, HI 96822 for information on grants, fellowships, assistantships, scholarships, tuition waivers, loans, work-study programs, and job opportunities.

Information on CTAHR graduate programs can be obtained from the Office of Academic and Student Affairs, Gilmore 210, (808) 956-8183, or from departmental offices.

Admission Requirements

Students must hold a bachelor's degree from an accredited U.S. college or university or its equivalent from a recognized foreign institution of higher learning. Admission requirements for various graduate programs are specified under each department's description. Admission decisions are made by the Graduate Division in consultation with faculty in the field of study.

College Requirements

The requirements associated with the master of science degree vary with each program of study. The master of science Plan A (thesis) and Plan B (non-thesis) options are available in all programs; entomology, tropical plant pathology, and tropical plant and soil sciences programs also offer a Plan C (examinations) option.

The PhD degree culminates in a set of comprehensive and final examinations and a dissertation of original work. Special requirements exist in some fields of study. Contact the Graduate Division or the departments for additional information.

Instructional and Research Facilities

Modern laboratories as well as statewide field laboratories are an important part of undergraduate and graduate instruction. Students are able to learn the latest research methods. Classrooms are well-equipped for learning computer applications.

Student Organizations

CTAHR students are encouraged to join and actively participate in student organizations. CTAHR student organizations provide opportunities for students to gain experience in their professional field through diverse activities. Students can acquire transferable skills and competencies outside of the classroom while gaining invaluable knowledge they can utilize in the work force. Developing lasting friendships with peers and faculty are also benefits of active participation in student organizations. Current CTAHR student organizations include:

- Innovators of Fashion
- Pre-Veterinary Club
- Food Science and Human Nutrition Council
- Tropical Plant and Soil Sciences Society
- Friends of the Family
- Student Ambassadors
- Natural Resources and Environmental Management Graduate Student Organization
- Ka Mea Kolo (Entomology Club)
- Tropical Plant Pathology Graduate Student Organization
- Biological Engineering Student Association
- Tropical Plant and Soil Sciences Graduate Student Organization
- CTAHR Club

Exceptional students may also be recommended for membership to honorary societies such as: Gamma Sigma Delta and Phi Upsilon Omicron.

Honors and Awards

The College of Tropical Agriculture and Human Resources and its departments provide scholarships and awards to its students. For a list of these scholarships, see the "Tuition, Fees, and Financial Aid" section of this *Catalog*. More information on scholarships and awards can be obtained from the CTAHR Academic and Student Affairs Office, Gilmore 210, (808) 956-8183.

Family and Consumer Sciences

Apparel Product Design and Merchandising
Miller 201
Tel: (808) 956-8133

Family Resources
Krauss Annex 7
Tel: (808) 956-6519

2515 Campus Road
Honolulu, HI 96822
Email: FCS@ctahr.hawaii.edu
Web: www.ctahr.hawaii.edu/FCS

Faculty

B. W. K. Yee, PhD (Chair)—Asia and Pacific Islander adult development and aging women's health, Southeast Asians, minority career paths
R. A. Caulfield, PhD—infancy, childhood, human development
M. Cheang, PhD—public health
D. R. Ching, PhD—agricultural leadership
J. L. Chong, MEd—adult and youth volunteer and leadership development (Hawai'i Cooperative Extension Service)
M. A. Cristi, MS—merchandising management; consumer behavior and sociology
C. D'Angelo, MFA, MA—costume museum management, fashion history and illustration
D. H. Davidson, PhD—cross-cultural child rearing, life span development
B. De Baryshe, PhD—parenting, family resilience
C. A. Dickson, PhD—fashion merchandising, international textile products markets
G. F. Fong, EdD—family resource management
H. Greenwood, MS—intergenerational and caregiving programs (Maui Cooperative Extension Service)
G. Heusel, EdD—human resource development
C. S. Ikeda, MEd—technology and education
L. J. Kawamura, MPh—4-H youth development, foods and nutrition (Kaua'i Cooperative Extension Service)
P. Kutara, MS—consumer economics (O'ahu Cooperative Extension Service)
S. Lin, PhD—apparel product development, computer applications in fashion industry
M. I. Martini, PhD—parenting and family relationships across cultures
D. M. Masuo, PhD—consumer and family economics
C. M. Nakatsuka, MEd—community service learning, 4-H (O'ahu Cooperative Extension Service)
A. H. Reilly, PhD—social psychology of appearance including body image
R. W. Saito, MA—4-H youth development (O'ahu Cooperative Extension Service)
R. L. Settlage, MS—4-H youth development, livestock (Hawai'i Cooperative Extension Service)
L. A. Yancura, PhD—stress and aging, research methodology

Degrees Offered: BS in apparel product design and merchandising (textiles and clothing), BS in family resources, MEd in early childhood education in conjunction with the College of Education

The Academic Program

The Department of Family and Consumer Sciences has been an integral part of the land-grant system and of UH since 1907. The department offers two bachelor of science degree programs: Apparel Product Design and Merchandising (APDM) and Family Resources (FAMR).

The APDM program integrates theoretical and applied knowledge regarding apparel design, consumer textiles, historic costume, apparel production, and apparel marketing and merchandising theory and practice, both domestic and international. The program fosters the development of professionals prepared for management-level positions in business and industry, such as apparel designer, buyer, merchandise manager, sales representative, costume designer, manufacturer, and store owner. An internship providing work experience related to a student's career interests is required. Majors complete a core of courses in subjects integral to apparel product development careers.

The FAMR program focuses on child and family studies. The FAMR curriculum emphasizes the study of child, adolescent, and adult development; family development (such as marriage and parenting); family resource management (such as consumer and family economics and family management); community needs; and leadership in human services occupations. The program requires an internship providing work experience related to a student's career interests. Students are prepared for bachelor-level careers in human and family services and for graduate training in child and family studies, early childhood education, human development, family-life education, family and consumer sciences, and marriage and family therapy. With supplemental course work, students may pursue graduate training in other social science disciplines such as social work, educational counseling, public health, and psychology.

In addition to courses offered in the department, there are opportunities for leadership experience and networking through professional and honor society organizations. *Phi Upsilon Omicron* is a national honor society in family and consumer sciences with membership by invitation. *Friends of the Family (FOF)* provides service and professional experiences for FAMR majors while *Innovators of Fashion (IF)* does the same for APDM majors. Majors from any discipline are welcome to join FOF and IF.

* Graduate Faculty

Undergraduate Study

Advising

Apparel Product Design and Merchandising
Miller 201
2515 Campus Road
Honolulu, HI 96822
Tel: (808) 956-8133
Email: fcs@ctahr.hawaii.edu

Family Resources
Krauss Annex 7
2515 Campus Road
Honolulu, HI 96822
Tel: (808) 956-6519
Email: fcs@ctahr.hawaii.edu

Students are encouraged to come for initial advising before registering for the first year at UH Mānoa or prior to their application for admission as a transfer student.

As part of the college program requirements, all APDM and FAMR degree candidates must fulfill one of the following Symbolic Reasoning courses: BUS 250, ECON 301, ICS 141, ICS 241, MATH 100, 111, 140*, 203*, 215*, 241*, NREM 203, PHIL 110, or 111. (Please note that MATH 103, 104, and 135 do not fulfill the symbolic reasoning requirement for APDM and FAMR.)

* Math Department's Precalculus Assessment required.

Apparel Product Design and Merchandising Program

Apparel Product Design and Merchandising (APDM) is a comprehensive undergraduate program whose mission is to prepare students with appropriate knowledge and skills for career positions in apparel and fashion-related industries. Classroom work is enhanced by the largest costume collection at a university in the U.S., giving students and faculty a rich source of items to draw upon for their classes and projects. New storage facilities and computerization make access simple. In addition, students have the opportunity to use web-based technologies to supplement classroom activities. Access to modern computer labs within the college make learning to do fashion illustration fun and challenging. Opportunities to study at other universities and to participate in study tours to fashion centers of the world are another plus. A strong foundation for graduate study in apparel and related areas is provided.

All APDM majors take a core set of courses that provides them with:

- An understanding of and appreciation for the impact of global production and distribution of apparel;
- The ability to plan, develop, and merchandise apparel product lines and to evaluate apparel quality;
- An understanding of the role of dress and fashion in their lives and the lives of others;
- An understanding of the design, manufacture, marketing, retailing, and consumption of textile and apparel products;
- The ability to demonstrate personal attitudes and skills appropriate to career positions in apparel.

The Curriculum

A strong APDM core includes required courses in apparel design, fashion promotion, merchandising, fashion illustration, historic costume, the social psychology of dress, and international trade. The core prepares students for career positions in both creative and business management areas of local and global fashion industries.

Entrance Requirements

New students may be admitted directly into the program when they apply to UH Mānoa. Students transferring from other colleges within the UH System or from other universities must have a minimum GPA of 2.5 to be considered for admission to APDM.

Minor

The merchandising minor gives students who are not APDM majors the opportunity to gain the required theory and applied skills to understand the merchandising/retailing function and skillfully employ techniques that encourage consumers to interface with products and services locally or internationally. Merchandising/retailing is the largest private employer segment of Hawai‘i’s business community.

Degree Requirements

A summary of degree requirements is available in Miller 201, (808) 956-8133 or Miller 110, (808) 956-8105.

Goals

From the core courses required of all APDM majors, students will develop:

1. The ability to evaluate textile and apparel product quality in terms of fiber and fabric performance, product standards and specifications, and consumer needs and preferences;
2. The ability to conduct comprehensive analyses of aesthetic elements in textile and apparel products and to estimate the effect of design decisions on target consumer markets;
3. The ability to apply theories, concepts, and principles to predict the direction of fashion change, to plan seasonal apparel product lines for discrete consumer groups, and to generate creative solutions to design and/or apparel merchandising and marketing problems;
4. The ability to describe current issues in textile and apparel design, production, and distribution systems; to assess the impact of global textile and apparel production and distribution practices on workers, consumers, and the environment; and to relate theories regarding markets, trade, and economic development to issues in the production, consumption, and disposal of textile products;
5. An understanding of concepts, theories and principles regarding the impact of dress on human behavior and its role in sustaining culture and in reflecting and fostering social change, and the ability to analyze and identify aspects of dress in historic and socio-cultural context;
6. The ability to identify, locate, analyze, and synthesize relevant information and to effectively communicate ideas in written, oral, and visual forms using appropriate technologies;
7. The ability to demonstrate personal attitudes and skills appropriate to career positions in fashion-related business and industry, and in related education and service organizations.

For information on a Bachelor Degree Program Sheet, go to www.manoa.hawaii.edu/ovcaa/programsheets/.

Family Resources Program

The Family Resources (FAMR) Program provides students with a comprehensive education in family development and resource management, including course work and study in the areas of family relations, parenting, family economics and resource management, consumer economics, human development, and community leadership and resource development. The curriculum prepares students to work proactively in multicultural settings to enhance the quality of family life, providing students with an understanding of:

- The changing needs and dynamics of families over time;
- The management of personal, family, and community resources to meet these needs;
- The growth and development of individuals over the human life cycle;
- The interrelationship of individuals, families, and communities in the context of diverse socio-economic and cultural systems.

Students gain a social systems perspective of how families operate by studying the theoretical and applied literature that addresses the biological, social, cultural, psychological, and economic well-being of individuals and families and the environments in which they live. Students also study the changing functions of the family, the roles of its members, and the community programs and policies that affect the decisions and well-being of families and consumers. FAMR courses also provide students with knowledge that they can apply to their personal development and family life. An internship in the student's area of focus is an integral part of the curriculum.

Entrance Requirements

New students may be admitted directly into the program when they apply to UH Mānoa. Students transferring from other colleges within the UH System or from other universities must have a minimum GPA of 2.6 to be considered for admission to FAMR.

Degree Requirements

A summary of degree requirements is available in Krauss Annex 7, (808) 956-6519 or Miller 110, (808) 956-8105.

Goals and Objectives

Students completing the FAMR degree are expected to achieve the following goals and objectives:

Goal 1: Acquire a knowledge base in human development.
- Objective 1. Demonstrate criterion level knowledge of stages, processes, and ranges of typical human development

Goal 2: Acquire a knowledge base in family science and resource management.
- Objective 1. Demonstrate criterion level knowledge of family diversity in the global community.
- Objective 2. Demonstrate criterion level knowledge of family resource management processes.

Goal 3: Acquire a knowledge base of the community context in which family functioning and development take place.
- Objective 1. Demonstrate criterion level knowledge of the effects of context (social, economic, political, historical, and cultural environment) on family functioning and development.

Goal 4: Acquire professional skills
- Objective 1. Demonstrate criterion level skills in written communication.
- Objective 2. Demonstrate criterion level skills in oral communication.
- Objective 3. Demonstrate a basic level of computer literacy.
- Objective 4. Demonstrate basic competence in "helping" skills.
- Objective 5. Demonstrate basic research skills.

Goal 5: Apply knowledge and professional skills to address issues encountered in professional settings.
- Objective 1. Demonstrate critical thinking skills and problem solving abilities.
- Objective 2. Demonstrate commitment to professional values and ethical behavior.
- Objective 3. Demonstrate a satisfactory level of preparation for the world of work and responsibility for continued professional growth.

For information on a Bachelor Degree Program Sheet, go to www.manoa.hawaii.edu/ovcaa/programsheets/.

Additional Opportunities

Provisional Certified Family Life Educator

The National Council on Family Relations (NCFR) has approved the family resources undergraduate program as meeting the standards and criteria required for the Provisional Certified Family Life Educator (CFLE) designation. Fully certified Family Life Educators work in the areas of program development, implementation, evaluation, teaching, training, and research related to individual and family well being. Among other activities, they conduct workshops in parenting, marital relationships, and resource management, in hospitals, HMOs, clinics, and schools. FAMR graduates who complete the specified courses in ten family life substance areas can apply to NCFR for Provisional Certification. Once a graduate has completed two years of work experience in preventive, educational activities related to family well being, the graduate can apply for full CFLE certification. FAMR internships, which include documented FLE activities may be used as part of the required work experience.

Master of Education in Early Childhood Education

The Department of Family and Consumer Sciences in the College of Tropical Agriculture and Human Resources and the College of Education Departments of Curriculum Studies and Special Education offer an interdisciplinary program leading to the degree of master of education in early childhood education.

MEd in early childhood education requirements are located in the College of Education Departments of Curriculum Studies and Special Education section of this *Catalog*.

Human Nutrition, Food and Animal Sciences

Agricultural Sciences 216
1955 East-West Road
Honolulu, HI 96822
Tel: (808) 956-7095
Fax: (808) 956-4024
Email: hnfas@ctahr.hawaii.edu
Web: www.ctahr.hawaii.edu/hnfas/

Faculty

*D. L. Vincent, PhD (Chair)—reproductive physiology and endocrinology
*M. A. Dunn, PhD (Graduate Chair, Nutritional Sciences MS and Nutrition PhD programs)—nutritional biochemistry, vitamins and minerals
*B. A. Buckley, PhD—beef production and breeding
*J. Dobbs, PhD—food composition, nutrition, domestic animals, avian and wildlife nutrition
*D. A. Dooley, PhD—diet and behavior, nutrition education, ethics of food choice
M. W. DuPonte, MS—livestock extension education (Hawai'i Cooperative Extension Service)
G. K. Fukumoto, MS—livestock extension education (Hawai'i Cooperative Extension Service)
*C.Y. Hu, PhD—animal growth, adipose differentiation, lipid metabolism
*A. S. Huang, PhD—food chemistry, taro processing
*W. T. Iwaoka, PhD—food chemistry, food safety, food science education
*S. Jun, PhD—food engineering, biosensors and processing control
N. A. Kanehiro, MS, RD—human nutrition extension education (O'ahu Cooperative Extension Service)
*Y. S. Kim, PhD—meat science, muscle biology, animal growth, biotechnology
*C. N. Lee, PhD—dairy production management and reproductive physiology
*Y. Li, PhD (Graduate Chair, Food Science)—food microbiology, food safety and probiotics
*S. R. Malecha, PhD—aquaculture production and breeding
*S. T. Nakamoto, MBA, PhD—marketing of perishable products, agricultural economics
L. C. Nakamura-Tengan, MS—consumer food safety, extension education and resource management (Maui Cooperative Extension Service)
*R. Novotny, PhD, RD—community and international nutrition, nutritional epidemiology, body composition
M. A. Segobiano, MS, CEC, CCE, CHE—chef instructor
*A. C. Shovic, PhD, RD—dietetics
M. H. Stevenson, MS—livestock extension education (Kaua'i Cooperative Extension Services)
*M. L. Stewart, PhD—nutrition, dietary fiber, gut health
*A. M. Stokes, DVM, PhD—veterinary medicine, cardiovascular physiology
*M. S. Thorne, PhD—range production and ecology (Hawai'i Cooperative Extension Service)
*C. A. Titchenal, PhD—nutrition and human performance, dietary supplements, nutrition journalism
*C. A. Watters, MSC, RD, PhD—clinical and community nutrition-evidence based practices
*J. Yang, PhD (Graduate Chair, Animal Sciences)—molecular biology and animal biotechnology
*H. M. Zaleski, PhD—swine production and management, reproductive physiology
J. M. Zee, MPH, RD—human nutrition extension education (Hawai'i Cooperative Extension Service)

Cooperating Graduate Faculty in Animal Sciences

E. G. Grau, PhD—fish endocrinology
B. W. Mathews, PhD—aquaculture and nutrition

Affiliate Faculty in Animal Sciences

*S. Atkinson, PhD—marine mammals
*I. Forster, PhD—aquaculture feeds and nutrition
C. Laidley, PhD—aquaculture reproductive endocrinology
K. R. Longnecker, PhD—invertebrate taxonomy and dietary analysis of Hawaiian monk seals
S. Moss, PhD—shrimp aquaculture
*B. Okimoto, DVM—exotic animal husbandry and diseases
A. Ostrewski, PhD—aquaculture
L. Polasek, PhD—marine mammal biology, wildlife and fisheries sciences
L. C. Rawson, DVM—animal diseases, health and welfare
T. B. Ron, PhD—aquaculture
M. Snover, PhD—reptile, wildlife management and conservation biology
K. L. West, PhD—marine mammal science and biology
L. A. Woodward, PhD—fish, wildlife management and conservation biology
T. M. Work, DVM—fish and wildlife, health and conservation biology

Cooperating Graduate Faculty in Food Sciences

*H. Ako, PhD—nutritional biochemistry, aquaculture, lipid metabolism
*D. Borthakur, PhD—microbiology, biotechnology
*R. S. Fujioka, PhD—water resources, food microbiology
*L. Gautz, PhD—instrumental quality evaluation
*Q. Li, PhD—analytical methodology to identify environmental toxins
*P. Q. Patek, PhD—microbiology
*R. Paull, PhD—fresh fruit and vegetable physiology and handling
*A. S. Saulo, PhD—food technology extension, food safety and quality
*W. W. Su, PhD—bioprocess engineering
*C. S. Tamaru, PhD—live feed, aquaculture

Cooperating Graduate Faculty in Nutritional Sciences

*M. J. Berry, PhD—selenoproteins, antioxidants and human diseases
*A. Franke, PhD—analytical chemistry, phytochemicals
*J. Grove, PhD—biostatistics
*R. Hetzler, PhD—exercise physiology, sports nutrition
*D. Jenkins, PhD—bioengineering
*L. Le Marchand, MD, MPH, PhD—nutritional epidemiology, genetic markers
*G. Maskarinec, MD, MPH, PhD—nutritional epidemiology, soy, hormones and cancer
*S. Murphy, RD, PhD—diet assessment, community nutrition
*P. V. Nerurkar, PhD—medical biochemistry
*C. R. Nigg, PhD—exercise behavior

* Graduate Faculty

Affiliate Graduate Faculty in Nutritional Sciences

R. Leon-Guerrero, PhD—obesity and chronic disease prevention, diet assessment
S. Sharma, PhD—nutritional epidemiology
A. Tacon, PhD—aquaculture in human nutrition
T. Vogt, MD—dietary intervention trials
S. Zaghloul, PhD—nutritional epidemiology, nutrition education

Cooperating Graduate Faculty in Nutrition PhD Program

C. L. Albright, PhD—intervention research on energy balance; weight control; physical activity; dietary fat, fiber, and fruits/vegetables
M. J. Berry, PhD—selenoproteins; antioxidants and human disease
R. Cooney, PhD—tocopherols, carotenoids and coenzyme Q-10 mechanisms of action in health and disease
A. Franke, PhD—analytical chemistry, lab assessments, phytochemicals
J. Grove, PhD—biostatistics/epidemiology
R. Hetzler, PhD—exercise physiology, sports nutrition
L. N. Kolonel, MD, PhD—nutrition and cancer, cancer epidemiology
J. D. Latner, PhD—clinical psychology, eating behaviors and disorders, obesity
L. LeMarchand, MD, MPH, PhD—nutritional epidemiology, genetic markers
Q. X. Li, PhD—environmental biochemistry, proteomics
G. Maskarinec, MD, MPH, PhD—nutritional epidemiology, soy, hormones and cancer
S. Murphy, RD, PhD—diet assessment, community nutrition
P. Nerurkar, PhD—metabolic disorders and alternative medicine
C. R. Nigg, PhD—theory of health behavior change, intervention, physical activity/exercise and nutrition behavior, research design

Affiliate Graduate Faculty in Nutrition PhD Program

S. Sharma, PhD—nutritional epidemiology, global nutrition
H. Turner, PhD—cell biology and immunology
T. Vogt, MD, MPH—dietary intervention trials

Degrees Offered: BS in animal sciences, BS in food science and human nutrition, MS in animal sciences, MS in food science, MS in nutritional sciences, PhD in nutrition

The Academic Program

The Department of Human Nutrition, Food and Animal Sciences (HNFAS) offers both undergraduate and graduate programs leading to BS, MS, and PhD degrees. Two BS degrees are available: animal sciences (ANSC) and food science and human nutrition (FSHN). Three MS degrees are offered: animal sciences, nutritional sciences, and food science. The department is also the home locus for the inter-college PhD program in nutrition. The MS and PhD programs are described under graduate study.

Animal science is the application of experimental investigation, cutting edge technology, and other scientific principles for the advancement of efficient and environmentally friendly animal agriculture and improved food quality and safety. Students receive training in both basic and applied agricultural systems, as well as in animal sciences. One focus of the animal science program is on pre-veterinary training but the program also emphasizes preparation for work in production and management systems for the major farm animals such as swine, sheep, beef and dairy cattle, and aquatic/aquaculture animals. Students are also exposed to the challenges of proper care/welfare and management of pets and companion animals (including horses), marine mammals, exotic wildlife and/or zoo animals, and aquaculture animals. Unlike most continental U.S. institutions, the emphasis of the present program is on tropical production systems with particular reference to the Pacific Basin or other subtropical regions. Animal scientists have careers in management and production, veterinary medicine, food processing and marketing, animal biotechnology, zoo and wildlife management, the pharmaceutical and feed and aquaculture industries, teaching, extension education, and research. Those positions require skills in disciplines such as nutrition, genetics, physiology, environmental and waste management, meat science and growth biology, animal health, feed and forage/browse utilization, engineering, business management/marketing and salesmanship. Other skills of critical importance are computer proficiency, written and oral communication, problem solving, and ability to build effective interpersonal relationships.

The undergraduate curricula in food science and human nutrition (FSHN) have a strong science base that is applied to food and human nutrition. Options in the curricula include dietetics, human nutrition, and science education. Interest in nutrition, food, and the relationship of food to human health and fitness has never been greater than today. Students majoring in any of the curriculum options are prepared for diverse careers in the food industry, health-care and fitness facilities, hospitals, nutrition education and communication enterprises, government or private-sector food and nutrition agencies, science related research laboratories, and science education. Students learn problem-solving skills, approaches to critical thinking and basic principles in two related disciplines. The dietetic option has been approved by the American Dietetic Association. The human nutrition option can be directed toward nutrition education, sports nutrition, or other interests. The human nutrition option can serve as a pre-professional program in medicine, dentistry, nutrition, or other scientific graduate programs. The science education option provides students with a curriculum that fulfills the academic requirements for a chemistry, biology, or general science certification as a secondary school science teacher. To complete certification requirements, a student can apply for the College of Education Post-Baccalaureate Certificate in the Secondary Education Program.

Students are strongly encouraged to take required chemistry and biological sciences courses prior to entering the program. Students who want to transfer into the food science and human nutrition (FSHN) program are required to have a minimum GPA of 2.8 and to have completed FSHN 185 with a grade of B (not B-) or better and to have completed the following courses with a grade of C (not C-) or better: MATH 140, PHYL 141/141L, PHYL 142/142L, CHEM 161/161L, and CHEM 162/162L.

Upon entering either program, animal sciences (ANSC) or food science and human nutrition (FSHN), students will be assisted by academic advisors to identify their career objectives and select an appropriate option for study.

Advising

All FSHN and ANSC majors are required to report for advising prior to registration each semester.

Undergraduate Study

BS in Animal Sciences/Pre-Vet

Degree Requirements

- Course work in the basic sciences, mathematics, economics, and animal sciences including the following:
  - MATH 140 or above
  - PHYS 151/151L
  - CHEM 161/161L, 162/162L, and 272/272L
  - NREM 220 or ECON 131
  - MBBE 402/402L
  - One of BIOL 171, MICR 130, or ZOOL 101
- Animal sciences required courses:
  - ANSC 200, 201, 244, 301, 321, 350, and 445
  - Four of the following: ANSC 446, 451, 453, 454/454L, 462, and 472
  - One of the following production courses: ANSC 431, 432, 433, and 450
- Additional electives to make a total of 128 credit hours

In order to enroll in animal science courses, all prerequisite courses must be passed with a grade of C (not C-) or higher.

Because of the diversity among fields of specialization within animal sciences, specific course requirements will vary considerably among students. On the recommendation of the student's major advisor, courses will be selected from those offered in animal sciences, as well as in natural resources and environmental management, bioengineering, anatomy and reproductive biology, biochemistry and biophysics, chemistry, environmental biochemistry, food science and human nutrition, genetics, tropical plant and soil sciences, information and computer sciences, microbiology, oceanography, physiology, and zoology.

For information on a Bachelor Degree Program Sheet, go to www.manoa.hawaii.edu/ovcaa/programsheets/.

Veterinary Science

Students interested in becoming veterinarians generally major in animal sciences, within the Department of Human Nutrition, Food and Animal Sciences, and participate in CTAHR's pre-veterinary curriculum. A BS degree is desirable but not required for veterinary schools. The CTAHR pre-veterinary advisor assists students in meeting the admission requirements of veterinary schools that participate in the Western Interstate Commission for Higher Education (WICHE) program, including the University of California-Davis, Colorado State University, and the Washington, Oregon, Idaho College of Veterinary Medicine at Washington State University. Hawai'i students are also encouraged to make applications to other continental U.S. veterinary schools that accept nonresident students. Students should contact the website of the Association of American Veterinary Medical Colleges for information about the Veterinary Medical College Application Service at www.aavmc.org/and for more information about specific requirements for admission to veterinary schools. The department also sponsors the Pre-Veterinary Club of Hawai'i, which offers students opportunities to interact with other students interested in veterinary medicine and working with animals. Students seeking additional information and advising should contact the Department of Human Nutrition, Food, and Animal Sciences, Agricultural Sciences Building, 1955 East-West Road, Room 216, Honolulu, Hawai'i 96822 (808) 956-7095.

BS in Food Science and Human Nutrition

Admissions

Incoming freshmen, transfer student from other majors, and transfer students from other institutions with interest in the Food Science and Human Nutrition (FSHN) major are classified as "pre-FSHN." A student will be accepted into the FSHN major when the following criteria are met: minimum 2.8 GPA; CHEM 161/161L and 162/162L, PHYL 141/141L and 142/142L, and pre-calculus or higher calculus completed with a C grade or better, and FSHN 185 completed with a B grade or better. Students interested in the Food Science option may be admitted directly into FSHN; please contact the undergraduate advising coordinator (Maria Stewart, PhD; mstew@hawaii.edu, (808) 956-9114.

Degree Requirements

Contact the Human Nutrition, Food, and Animal Science Department for current degree requirements, Ag Sci 216, 1955 East-West Road, (808) 956-7095.

Dietetics Option

Students choosing a professional career as a registered dietitian (RD) and who desire to do nutrition counseling should select the academic course work outlined in this option. This option meets the undergraduate academic requirements established by the American Dietetic Association (ADA), to become a registered dietitian. Upon receiving a bachelor of science degree, students must be accepted into an accredited internship or an approved pre-professional practice program. Upon successful completion of a 6 to 11 month internship, or Preprofessional Practice Program, the student is eligible to take the national dietetic registration examination administered by the Commission on Dietetic Registration. Students generally need to have a GPA of 3.0 or above to be competitive for internship programs. Students may contact Dr. Anne Shovic ((808) 956-3847, email: shovic@hawaii.edu), the Dietetics Program Director, and are encouraged to refer to the Dietetics Option Student Handbook for more information about this option (www.ctahr.hawaii.edu/hnfas/degrees/undergrad/Dietetics_Student_Handbook.pdf). Work and/or volunteer experience in the field of interest is highly recommended.

For information on a Bachelor Degree Program Sheet, go to www.manoa.hawaii.edu/ovcaa/programsheets/.

Pre-professional Option

This course of study allows students to prepare for post-baccalaureate study in nutrition and nutrition-related disciplines. With guidance from their advisor, students can design a course of study to prepare them for post-baccalaureate studies in health professional programs (medicine, dental, pharmacy, etc.), or a graduate degree program in nutrition or other biomedical science. This course of study does not meet all of the undergraduate academic requirements of the American Dietetic Association to apply for a dietetic internship.

For information on a Bachelor Degree Program Sheet, go to www.manoa.hawaii.edu/ovcaa/programsheets/.

Sports and Wellness Option

Students who are interested in pursuing a career in sports and wellness, are encouraged to complete course work in Applied Musculo-skeletal Anatomy, Exercise Physiology (KRS 353, 354, and 354L), and Nutrition in Exercise and Sport (FSHN 480). These recommended courses can be added to the dietetics program option if the student desires to do professional nutritional counseling or be taken as electives in the human nutrition option if the student intends to pursue graduate studies.

For information on a Bachelor Degree Program Sheet, go to www.manoa.hawaii.edu/ovcaa/programsheets/.

Food Science Option

This study track educates and develops skills in students who desire to work in food processing, regulation, and food business arena, both in the public and private sector. This track also prepares students for managerial positions since there is a high demand for people with skills in food science and knowledge of business, accounting, and interpersonal skills. Students learn about food chemistry, microbiology, structure, engineering, safety, regulation, sanitation, quality control, and business-oriented courses.

Requirements

In order to enroll in food science and human nutrition courses, all prerequisite courses must be passed with a grade of C (not C-) or higher.

A total of at least 128 credits are required for graduation. Students seeking additional information and advising should contact the Department of Human Nutrition, Food and Animal Sciences, Agricultural Sciences Building, 1955 East-West Road, Room 216, Honolulu, HI 96822; (808) 956-7095, email: hnfas@ctahr.hawaii.edu.

Graduate Study

The department offers graduate programs leading to MS and PhD degrees. Students can choose from three MS degree options: animal sciences, nutritional sciences, or food science. The department is also the home locus for the inter-college PhD program in nutrition. Admission and degree requirements for each program are listed below, but are subject to change. For current information, contact the Department of Human Nutrition, Food and Animal Sciences, Agricultural Sciences Building, 1955 East-West Road, Room 216, Honolulu, HI 96822; (808) 956-7095, email: hnfas@ctahr.hawaii.edu.

MS in Animal Sciences

The MS in animal sciences is offered in both the basic and applied areas of genetics, nutrition, physiology, reproduction, animal health, molecular biology of growth and metabolism, and animal muscle biology.

Specialty areas consist of beef-cattle nutrition, grazing management, and genetics; dairy-cattle nutrition and physiology (especially the management of cattle in a hot climate); swine management; reproductive physiology and endocrinology of sheep, cattle, fish and swine; molecular biology of animal growth and metabolism; muscle biology and meat science; reproduction, animal health; nutrient/waste management; and freshwater and saltwater shrimp breeding and production, nutrition, and pond management systems. Emphasis is placed on the application of scientific methods for both the development and improvement of animal industries in subtropical and tropical environments. There is also the opportunity for cooperative studies in the areas of care/welfare and management of pets and companion animals (including horses), marine mammals, exotic wildlife, and/or zoo animals. Candidates wishing to specialize in animal breeding and genetics should be particularly strong in mathematics, including statistics, with a good biological background.

Admission Requirements

To be considered for admission to the animal sciences program, an applicant must (1) hold a bachelor's degree with a major in animal science (or the equivalent thereof) from an accredited institution of higher learning with a GPA of 3.0 or higher, (2) provide evidence of superior scholarship in previous academic work, (3) arrange for three letters of recommendation, (4) submit GRE general test scores, (5) submit an application including a statement of objectives, (6) submit a resume, and (7) submit a TOEFL score of 580 minimum, 600 recommended (250 computer) if a foreign student. Interviews by phone or in person in Hawai'i may be requested by the admissions committee. An applicant with a bachelor's degree in a major other than animal or veterinary sciences who otherwise qualifies for admission will be required to take ANSC 200 or 201, one production course, and such other undergraduate courses deemed necessary by the department as essential background to the applicant's studies. The ANSC 200 or 201 requirements may be satisfied through meeting the teaching experience requirement.

The deadlines for receipt of all application materials are **February 1** for fall applicants, and **September 1** for spring semester applicants.

Degree Requirements

Plan A (Thesis)

Students must complete a minimum of 30 credit hours, including:

- At least 18 credits of course work at the graduate level, 12 of which must be at the 600 level or above (excluding 699 and 700) including two credits of ANSC 641 (Seminar in Animal Sciences) and FSHN 601;
- a maximum of 2 credits of Directed Research (ANSC 699); and
- 10 credits of Thesis Research (ANSC 700).

Plan B (Non-thesis)

Students must complete a minimum of 30 credit hours, including:

- At least 18 credits in course work numbered 600 and above (excluding 699), including two credits of ANSC 641 and FSHN 601.
- 6-9 credits of Directed Research (ANSC 699).
- Remaining credits must be at the graduate level.

Both Plan A and B

A general exam on basic knowledge in the animal sciences is required of all students to advance to candidacy for the MS degree. A final exam based on the student's Plan A Thesis Research or Plan B Directed Research is also required. Students

are required to attend weekly seminars each semester and present a minimum of three formal seminars during their graduate training (including their thesis defense). A maximum of 2 credits is allowed for graduate seminar (ANSC 641). The following courses are recommended as a core for most graduate students in animal sciences: ANSC 642, 643, 644, 650, 652, 657, 687, and a graduate-level statistics course.

Each student will be required to serve as a teaching assistant (TA), in either a paid or non-paid status, for a minimum of one course for one semester. This experience must include leading laboratory or discussion sections, and evaluation by the instructor.

In both plans (on the recommendation of the student's graduate committee), the graduate credit hours will be selected from the graduate courses offered in animal sciences or other related disciplines such as anatomy and reproductive biology, biochemistry, chemistry, genetics, microbiology, physiology, public health, zoology. Because of the diversity of specializations within animal sciences, specific course requirements will vary considerably among students. Further information is available at www.ctahr.hawaii.edu/hnfas/degrees/grad/ANSC.html.

MS in Nutritional Sciences

The MS in nutritional sciences prepares students to understand the scientific basis of nutrition, its application to health and fitness, and the skills needed to conduct basic and applied nutrition research. Subject areas of concentration include clinical nutrition, obesity, dietary fiber, functional fiber and bioactive food components, diet and cancer, mineral nutrition and toxicology, sports nutrition, nutrition education, nutritional product development, community and international nutrition, nutritional biochemistry, and nutritional epidemiology. Cooperating programs include public health, kinesiology and rehabilitation science, food science, animal sciences, physiology, the John A. Burns School of Medicine, and the Cancer Research Center of Hawai'i.

Depending on the area of focus, students are prepared for diverse careers in nutrition and food-related industries, government agencies, and academic institutions. Graduates have found employment as college instructors; nutrition educators or consultants in the private sector; nutritionists in the food industry, fitness facilities, or health-related government agencies; and as research scientists in the health-care industry, private sector, government, or academic research institutions. Many have pursued PhD or other professional degrees at major universities around the country.

Admission Requirements

Academic prerequisites include a bachelor's degree in nutrition or a closely related field, a minimum grade point average of 3.0, and undergraduate course work in nutrition, physiology, biochemistry, and statistics. Motivated students without a nutrition related degree may apply, but will be expected to make up undergraduate course deficiencies if admitted into the program. Students are strongly encouraged to take introductory science courses prior to applying to the program including at least two of the above mentioned prerequisites (one preferably being introductory nutrition). Additional requirements include submission of GRE General Test scores (no minimum score required), two confidential recommendations (using our program's recommendation forms), a TOEFL score of 580 minimum, 600 recommended (250 computer, 100 internet) if a foreign student; a personal resume; and a completed Graduate Admissions Application including statement of objectives. Interviews by phone (or in person if in Hawai'i) may be requested by the admissions committee. The deadlines for receipt of all application materials are **February 1** for fall semester applicants, and **September 1** for spring semester applicants.

Further information is available at www.ctahr.hawaii.edu/hnfas/degrees/grad/NUTRms.html.

Degree Requirements

Two MS degree options are available: Plan A (thesis) and Plan B (non-thesis). Generally, students are expected to follow Plan A unless the Plan B option is approved by the graduate chairperson and the student's advisor.

Plan A (Thesis)

Students must complete a minimum of 30 credit hours, including:

- 18 credit hours of coursework at the graduate level, 12 of which must be at the 600 level (excluding 699 and 700);
- 2 credits of Directed Research (699); and
- 10 credits of Thesis Research (700).

Plan B (Non-thesis)

Students must complete a minimum of 30 credit hours, including:

- At least 18 credit hours of coursework at the 600 level or above (excluding 699) and
- 6-9 credits of Directed Research (699); and
- Remaining credits are fulfilled by graduate level electives that are selected in consultation with the graduate advisor.

Both Plan A and B

All students are required to pass an oral exam of basic nutrition knowledge to advance to candidacy for the MS degree, and pass a final exam/oral defense of their Thesis Research (Plan A) or Directed Reading and Research (Plan B). The following courses are required as a core for most graduate students in nutritional sciences: FSHN 601, 681, 682, 685, 689, and a graduate-level statistics course. Students are required to register for Seminar in Food and Nutritional Sciences, FSHN 681, during four semesters, and present a minium of two seminars for a letter grade (A-F) during their graduate program. Each student will be required to serve as a teaching assistant (TA), in either a paid or non-paid status, for a minimum of one semester. This experience must include a significant instructional component and evaluation by the instructor.

In both plans (in consultation with the student's graduate committee), the graduate credit hours will be selected from the graduate courses offered in nutritional sciences as well as other related disciplines such as food science, cell and molecular biology, epidemiology, genetics, physiology, public health, kinesiology, and statistics. Because of the diversity of specializations within nutritional sciences, specific course requirements will vary among students. Please see our website at www.ctahr.hawaii.edu/hnfas/degrees/grad/NUTRMS.html.

MS in Food Science

The MS in food science offers areas of concentration in food safety and quality, food processing and engineering, food chemistry and biochemistry, food microbiology, product development, and food science education. Graduates have found employment as college instructors, technical personnel in the food industry, regulatory or other governmental agencies, and researchers. Others have pursued further postgraduate studies.

Admission Requirements

Academic prerequisites include a bachelor's degree in food science or a closely related field, a minimum grade point average of 3.0, and undergraduate course work in introductory foods, biochemistry, introductory nutrition, and statistics. Motivated students without a food science-related degree may apply, but will be expected to make up undergraduate deficiencies if admitted. Students are strongly encouraged to take chemistry and introductory food courses prior to applying to the program.

Additional requirements include: submission of GRE General Test scores (no minimum score required); two confidential recommendations (using our program's recommendation forms); a TOEFL score of 580 minimum, 600 recommended (250 computer) if a foreign student; a personal resume; and a completed Graduate Admissions Application including statement of objectives. Interviews by phone or in person if in Hawai'i may be requested by the admissions committee. The deadlines for receipt of all application materials are **February 1** for fall semester applicants, and **September 1** for spring semester applicants.

Degree Requirements

Plan A (Thesis)

Students must complete a minimum of 30 credit hours, including:

- At least 18 credit hours of course work, 12 of which must be at the 600 level or above (excluding 699 and 700)
- 2 credits of Directed Research (699); and
- 10 credits of Thesis Research (700)

Plan B (Non-thesis)

Students must complete a minimum of 30 credit hours, including:

- At least 18 credit hours of course work at the 600 level or above (excluding 699); and
- 6 to 9 credits of Directed Research (699); and
- Remaining credits are fulfilled by graduate level electives that are selected in consultation with the graduate advisor.

Both Plan A and B

All students are required to pass an oral exam of basic knowledge in food science to advance to candidacy for the MS degree, and a final exam/oral defense of their Thesis Research (Plan A) or Directed Research (Plan B). Students are required to register for Seminar in Food and Nutritional Sciences (FSHN 681) during four semesters, and present a minimum two seminars for a letter grade (A-F) during their graduate program. The following courses are required as a core for graduate students in food science: FSHN 601, 607, 608, 681, 701, and a graduate-level statistics course. Each student will be required to serve as a teaching assistant (TA), in either a paid or non-paid status, for a minimum of one course for one semester. This experience must include a significant instructional component and evaluation by the instructor.

In both plans (in consultation with the student's graduate committee), the graduate credit hours will be selected from graduate courses offered in food science as well as other related disciplines such as biochemistry, nutrition, microbiology, genetics, biotechnology, cell and molecular biology, and statistics. Because of the diversity of specializations within food science, specific course requirements will vary among students. Further information is available at www.ctahr.hawaii.edu/hnfas/degrees/grad/FSHN.html.

PhD in Nutrition

In today's world, the relationship between diet and health is of great interest among consumers, medical professionals, research scientists, government policy makers, and private industries related to food, agriculture, and healthcare. To serve these clients and improve human health, especially in Hawai'i and the Asia-Pacific region, the PhD program in nutrition is designed to prepare future leaders and innovators who can expand our knowledge about food and health, solve nutrition-related problems, propose effective nutrition policies, guide new product and service development, and be ethical and effective researchers, communicators, and educators. To ensure that graduates are prepared for these roles, students will be expected to demonstrate:

1. Comprehensive understanding of core nutrition knowledge;
2. Advanced scholarship in a specialty area (i.e., expertise in a least one overlapping biomedical discipline e.g., biochemistry, physiology, cell and molecular biology, food science/functional foods, epidemiology, biostatistics, medicine, etc.);
3. Appropriate exposure to social and career-building disciplines (e.g., education, communications, information technology, technical writing, social sciences, etc.);
4. Ability to conduct original scholarly research, develop skills in research methodologies and grant writing, understand research ethics, and effectively dissemination research findings via peer-reviewed publications, seminars, and practical applications such as teaching.

To accomplish these goals, the PhD program integrates faculty and resources from the instructional and research programs housed in the College of Tropical Agriculture and Human Resources (CTAHR), the John A. Burns School of Medicine (JABSOM), and the University of Hawai'i Cancer Center to create an inter-college PhD program that will produce highly marketable, interdisciplinary graduates that can assume leadership roles in the field of nutrition.

Admission Requirements

The admission process is considered a critical step in insuring the success and quality of the program and its graduates; therefore, applicants will be carefully evaluated and selected. The admissions committee is chosen and led by the graduate chair and is made up of graduate faculty with proven records in mentoring successful graduate students. To insure consistent quality of training and financial support, the number of applicants admitted will be kept in line with the availability of high-quality

dissertation advisors and available support. Students will not be admitted without a plan to support them and evidence of a faculty member's willingness to serve as a dissertation advisor.

Applicants should have a BS or MS degree in nutrition or a closely related biological science; however, highly motivated students with other degrees may be considered if they have excellent academic backgrounds and demonstrated strength in the biological sciences. Applicants are expected to demonstrate adequate preparation in nutrition, biochemistry, physiology, and statistics. If admitted without sufficient preparation in theses areas, these prerequisites must be made up early in the student's program. The admissions committee will determine course deficiencies in an applicant's background.

Additional admission requirements include a minimum grade point average of 3.4 out of 4.0 for applicants with a BS, and 3.6 out of 4.0 for applicants with a MS or other advanced degree; submission of GRE general test scores that demonstrate performance above the 50% percentile in all areas; three letters of recommendation from individuals that can comment on academic and research potential, a personal resume, and a completed Graduate Admissions Application including a personal statement of objectives that includes reasons for wanting to attend graduate school, research interests, and career goals. Foreign applicants must obtain a minimum TOEFL score of 600 (paper), 250 (computer), or 100 (internet). Interviews (in person or by phone) are required of all applicants deemed admissible by the admissions committee. In selecting applicants for admission, particular attention will be paid to the quality and depth of the personal statement, the strength of the letters of recommendation (i.e., they must indicate exceptional potential), and the professional qualities and academic depth presented in the personal interview.

The deadline for receipt of all application materials are **February 1** for fall and **September 1** for spring applicants.

Further information is available at www.ctahr.hawaii.edu/hnfas/degrees/grad/NUTRphd.html.

Degree Requirements

The principal requirements for the PhD degree are:

1. Pass a qualifying examination for admission to candidacy,
2. Complete required coursework,
3. Pass a comprehensive exam to demonstrate advanced scholarship in the field, and
4. Defend a doctoral dissertation that presents original, independent research.

In addition, all PhD candidates are required to participate in a substantial teaching project with a graduate faculty mentor during at least one semester of their program (if entering with a BS, two semesters are required).

Qualifying exam. The purpose of the qualifying exam is to evaluate the student's basic knowledge in nutrition-related fields, determine if the student has a strong enough background to proceed successfully with their doctoral program, and enable advisors to assist the student in planning an appropriate program of study. The areas covered by the exam include basic nutrition, biochemistry, physiology, statistics, epidemiology, and experimental design. The exam may be oral and/or written as decided by the examining committee. The committee will consist of at least three members of the graduate faculty chosen by the student in consultation with their advisor, and must be approved by the graduate chair. The exam is repeatable once after successful petition to the graduate chair. Students entering the program with a BS degree will be required to pass the qualifying exam within the first two years of their program. Candidates entering with a MS or other advanced degree must pass the exam within one year. Extensions can be made for students with course deficiencies to make up. Students entering from the nutritional sciences MS program at UH Mānoa within five years of receiving their MS degree are exempt from the exam, as suitability for the PhD program will be assessed during their MS program via the candidacy exam and thesis defense/final exam.

Dissertation proposal defense. Students entering with a BS degree are required to defend their dissertation research proposal to the satisfaction of their dissertation advisor and proposal defense committee. They must do this after they pass their qualifying exam and after they have met all other requirements for the Plan A master's degree in nutritional sciences except the completion of a formal thesis. This proposal defense serves as a capstone, similar to a MS thesis defense, and assures that the student can demonstrate sufficient research skills and knowledge of the research plan to proceed with the dissertation research. The dissertation proposal defense committee will consist of the student's advisor and at least two members of the graduate faculty chosen by the student in consultation with their advisor, and must be approved by the graduate chair. The student must pass the proposal defense to be eligible for the comprehensive exam. The defense is repeatable once after successful petition to the graduate chair.

Required course work. PhD students are required to have at least 18 credits of graduate level coursework (excluding research credits) beyond their MS degree. If entering with a BS degree, at least 36 credits of graduate level coursework (excluding research credits) beyond the BS are required. These course requirements are described below.

Students entering with a BS degree are required to meet all requirements for the Plan A master's degree in nutritional sciences, excluding the production of a formal written thesis. The course requirements include any course deficiencies recommended by the admissions committee plus the following 18 credits of graduate level coursework:

- 11 credits of required nutrition courses (FSHN 601, 682, 685, 689) including 2 credits of Seminar in Nutritional Sciences (FSHN 681)
- 3 credits in statistics at the graduate level (e.g. PH 655 Biostatistics I)
- 4 credits of advisor-approved electives (2 of which must be at the 600 level)

In addition, at least 12 credits of Directed Research (699) are required.

Students entering with a MS or other advanced degree are required to make up any course deficiencies in their background prior to taking the qualifying exam. Course deficiencies will be assessed by the admissions committee. Credits obtained by making up course deficiencies cannot be used to meet the 18 credit course requirements for the PhD.

After the above requirements are met by students entering with a BS or MS, all continuing PhD students must take

a minimum of 18 credits of course work (excluding research credits) consisting of at least:

- 6 credits of graduate nutrition courses including 2 credits of Seminar in Nutritional Sciences (FSHN 681)
- 6 credits in graduate level courses that will foster development of a specialty area in a field overlapping with the discipline of nutrition. For example: biochemistry, cell and molecular biology, epidemiology, medicine, biostatistics, functional foods/food science.
- 6 credits in graduate level courses from career-building disciplines such as communications, education, information technology, technical writing, or social sciences.

The student in consultation with his or her dissertation advisor will decide on the specific courses used to meet the above 18-credit requirement. An example of a model course of study for a student entering with a BS in nutrition, and examples of available specialty area courses and career-building courses are available on our program website at: www.ctahr.hawaii.edu/hnfas/degrees/grad/NUTRPhd.html.

Required teaching experience. To foster teaching skills, all PhD candidates must participate in a substantial teaching project during at least one semester of their program. All students who are not paid teaching assistants are required to develop, with an instructor of their choice, an instructional experience equivalent to a quarter time teaching assistantship (10 hours per week) that includes in-class lectures/instructional activities, or laboratory instruction. At the conclusion of the experience, their instructional mentor must submit a written evaluation of their performance to the graduate chair. Unsatisfactory evaluations will result in the need to repeat the experience until a favorable evaluation is achieved. Students entering with a BS must additionally fulfill the instructional experience required as part of the MS in nutritional sciences (6 hours per week for one semester) prior to sitting for their dissertation proposal defense.

Comprehensive exam. When candidates have completed all, or most of their coursework toward the PhD, they must pass a comprehensive exam to verify that they can function as a professional in the field. The timing of the exam will be decided upon by the student in consultation with their advisor. The purpose of this exam is to determine the student's comprehension of fundamental nutrition knowledge, expertise in an overlapping discipline, and competence in research, communications, and critical thinking skills. The form of the exam is both written and oral. It will be conducted by an examination committee composed of at least three members of the graduate faculty (excluding the student's advisor) with collective expertise to cover the range of expectations listed above. The composition of the committee is proposed by the student in consultation with their advisor. To insure the quality and consistency of exam committees, its composition must be approved by the graduate chair. The time frame and grading of the exam will be decided by the committee. The examination criteria and procedures will conform to the Graduate Division's standards for all Mānoa doctorate programs. A student must pass this exam to remain in the PhD program. The exam is repeatable once after successful petition to the graduate chair. After passing the exam the student is eligible to formally select their doctoral committee as described below.

Dissertation

All PhD candidates must conduct scholarly, independent, original research that contributes new knowledge to the field. The candidates develop and conduct research projects under the direction of their dissertation advisor and doctoral committee. The doctoral committee is selected by the student in consultation with their dissertation advisor, and must be approved by the graduate chair. The dissertation advisor (chair of the doctoral committee), and a majority of the committee members must come from the nutrition graduate faculty. The committee must have at least 5 members, with one member being from a graduate faculty outside the student's field of study and area of specialization. At the conclusion of the research process, students write a dissertation, i.e. a scholarly presentation of their research in publication form. The student's doctoral committee then conducts a final examination to assess the student's ability to orally present their dissertation in a seminar format, and defend their research and written dissertation. The final exam is repeatable once after successful petition to the Graduate Dean. The dissertation, final exam criteria and procedures will conform to the Graduate Division's standards for all UH Mānoa doctorate programs. Further information is available at: www.ctahr.hawaii.edu/hnfas/degrees/grad/NUTRPhd.html.

Honors and Awards

The department has several teaching assistantships, research assistantships, and scholarships that are awarded to deserving qualified students.

Molecular Biosciences and Bioengineering

Agricultural Science 218
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mbbe@ctahr.hawaii.edu
Web: www.ctahr.hawaii.edu/mbbe/

Faculty

*H. Ako, PhD (Chair)—aquaculture, environmental biochemistry and biotechnology

*J. P. Bingham, PhD—peptide synthesis, marine neurotoxins

*D. Borthakur, PhD (Graduate Chair)—plant-microbe interaction, plant biotechnology

*D. Christopher, PhD—photosynthesis, photosensory signal transduction, gene regulation, genomics

*L. D. Gautz, PhD—bioproduction control and automation, electromechanical systems engineering

*A. Hashimoto, PhD—bioengineering

*D. M. Jenkins, PhD, PE—biosensors and bioinstrumentation

*S. Khanal, PhD, PE—bioenergy and bio-based products; waste to energy heat and mass transport in chemically reacting ecosystems, energy conversion, bioremediation

* Graduate Faculty

*C. Kinoshita, PhD—heat and mass transport in chemically reacting systems, energy conversion, bioremediation
*Q. Li, PhD—bioremediation, environmental biotechnology
*P. Nerurkar, PhD—carcinogen-induced metabolic disorders and biochemical mechanisms of environmental carcinogenesis
*G. Presting, PhD—bioinformatics
*W-W. Winston Su, PhD—biochemical engineering, cell culture engineering

Graduate Faculty in Molecular Biosciences and Bioengineering

All faculty of the department are regular graduate faculty in Molecular Biosciences and Bioengineering.

Cooperating Graduate Faculty

A. Alvarez, PhD—plant-pathogen interactions, biocontrol of plant diseases
R. Allsopp, PhD—stem cells, regulation of telomerase expressor in cells
A. S. Bachmann, PhD—tumor growth and cell differentiation
C. Boyd, PhD—biochemistry, cell molecular biology
M. Carbone, MD, PhD—cancer biology
S. Chang, PhD—vaccine development, molecular immunology
E. D. H. Cheng, PhD—hydrology, hydrolics, wind engineering
M. Cooney, PhD—marine biotechnology
H. G. de Couet, PhD—molecular biology, invertebrate biology, biotechnology
M. Dunn, PhD—molecular nutrition
T. Ernst, PhD—magnetic resonance imaging
G. Grau, PhD—marine biology
C.-E. Ha, PhD—biochemistry, human serum albumin
T. Hoang, PhD—molecular microbiology
J. Hu, PhD—plant virology
Y. S. Kim, PhD—animal biotechnology
C. C. Liu, PhD—bioengineering
P. S. Lorenzo, PhD—cancer biology
S. M. Masutani, PhD—thermal conversion of biomass
W. C. McClatchey, PhD—molecular evolution, conservation biology
C. Morden, PhD—molecular systematics
V. Nerurkar, PhD—molecular virology and epidemiology
J. Ramos, PhD—cancer biology
C. Ray, PhD—ground water hydrology, bioremediation
R. Shohet, MD—molecular medicine
V. A. Stenger, PhD—magnetic resonance imaging
C. Tamaru, PhD—aquaculture
S. Q. Turn, PhD—biomass gasification
G. Wang, PhD—marine microbial biotechnology
A. A. Yanagihara, PhD—biochemistry, peptide toxins
J. Yang, PhD—animal molecular biology and biotechnology
J. Yu, PhD—bioengineering, marine bioproduct development

Affiliate Graduate Faculty

H. H. Albert, PhD—plant molecular biology and biotechnology
C-S. Lee, PhD—aquaculture
P. H. Moore, PhD—sugarcane biotechnology, plant molecular biology
A. J. Stokes, PhD—cell biology
J. Zhu, PhD—plant transformation, biotechnology

Degrees Offered: BS in biological engineering, MS in biological engineering, MS in molecular biosciences and bioengineering, PhD in molecular biosciences and bioengineering

The Academic Program

The Molecular Biosciences and Bioengineering Department (MBBE) features a multidisciplinary faculty having a broad spectrum of interests in biotechnology, molecular biology, biochemistry, and biological engineering. The department's strong basic and applied research programs and its active, internationally recognized faculty combine to provide students with exciting learning opportunities. The department houses degree-granting programs in biological engineering (BS and MS) and in molecular biosciences and bioengineering (MS and PhD) and participates in the interdepartmental Plant and Environmental Biotechnology Program (BS).

Biological Engineering Program

The mission of the biological engineering (BE) program is to provide engineering students a unique opportunity to study biological systems from the engineering perspective. The biological engineering program teaches the importance of the systems approach to problem solving. Undergraduate (BS) and graduate (MS) degrees are offered in biological engineering.

Undergraduate Study

BS in Biological Engineering

The mission of the biological engineering program is to provide students a unique opportunity to study the fundamentals of engineering and biology and the application of engineering to biological systems. Example applications in biological engineering include processing of biomass for alternative energy uses or added value, bioreactor design for producing high-valued biologically-based products, bioremediation and biological treatment of wastes, and sensors and control engineering for biological systems. Undergraduates complete a comprehensive curriculum including the basic sciences (biology, chemistry, and physics), engineering mathematics, core engineering (civil, electrical, and mechanical), and fundamental and specialized biological engineering courses. Students receive integrated training in biology and engineering, culminating in a two-semester engineering design sequence.

To fulfill its mission, the BE program has three educational objectives, each associated with several outcomes:

1. Graduates enter professional careers where they apply fundamental engineering concepts to solve real-world problems;
   a. the graduate has the ability to solve physics problems involving mechanics, electromagnetics, and optics; chemistry problems involving inorganic and organic chemistry; problems involving general and microbiology;
   b. the graduate has the ability to solve engineering problems related to statics, dynamics, fluid mechanics, and thermodynamics.
2. Graduates serve the needs of the society by designing, manufacturing, evaluating, and/or operating systems in which living organisms or biological products are a significant component; and
   c. the graduate has the ability to design a system, component, or process in which biology plays a significant role;
   d. the graduate has the ability to design and conduct experiments to gather information for engineering designs;

e. the graduate has the ability to use modern engineering techniques, skills, and tools to define, formulate, and solve engineering problems.

3. Graduates contribute to their communities by continuing to engage in professional development, ethical decision making, and thoughtful discourse on contemporary issues.

f. The graduate has the ability to function effectively on multi-disciplinary teams.
g. The graduate has the ability to identify professional and ethical responsibilities when practicing engineering.
h. The graduate has the ability to communicate effectively in large and small groups.
i. The graduate has the background to understand the impact of engineering solutions on the surrounding context.
j. The graduate recognizes the need to engage in life-long learning through participation in professional conferences, workshops, and courses, and by reading and writing in the relevant literature.
k. The graduate has the ability to intelligently discuss contemporary issues.

The bachelor of science in biological engineering is the only undergraduate degree offered by the program. Students benefit from small class size and one-on-one interactions with faculty.

Requirements

General Education requirements, including the following:

- ENG 100 or approved FW course (FW)
- Two approved courses in Global and Multicultural Perspectives (FG)
- ECON 120 or 130 or 131 (DS)
- CHEM 161/161L and 162/162L (DP/DY)
- PHYS 170/170L and 272/272L (DP/DY)
- BIOL 171/171L (DB/DY)
- MATH 241, 242, 243, and 244 (FS)
- One Social Science course (DS)
- Six credits Humanities, Arts, and Literatures course (DH, DA, or DL)
- One course with focus on Contemporary Ethical Issues (E)
- One course with focus on Hawaiian, Asian, or Pacific issues (H)
- One course with focus on Oral Communication (O)
- Five Writing Intensive courses (W)
- Hawaiian or Second Language (HSL) is not required for the Bioengineering degree

College requirements:

- NREM 310

Basic engineering requirements:

- EE 160 and 211
- CEE 270 and 271
- ME 311
- CEE 320 or ME 322
- Engineering mathematics elective (MATH 302, 307, 311, ME 360, or CEE 417)

Bioengineering requirements:

- BIOL 172/172L or MICR 351/351L
- Biology elective (BIOL 275/275L, MICR 351/351L, or MICR 485/485L
- CHEM 272/272L
- BE 260, 350/350L, 373, 481, and 482
- At least 15 credits from courses BE 405, 410, 411, 420, 421, 431, 437, 440, 460, 470, CEE 355, or ME 371

Students must have completed a cumulative total of at least 128 credit hours and take (but not necessarily pass) the NCEES Fundamentals of Engineering exam in the semester they intend to graduate.

For information on a Bachelor Degree Program Sheet, go to www.manoa.hawaii.edu/ovcaa/programsheets/.

Graduate Study

MS in Biological Engineering

The research areas in biological engineering open to MS students include management of wastes and wastewater; engineering for cell culture, fermentation, micropropagation, and bioconversion; engineering-intensive horticultural and aquatic biosystems; modeling and optimization of bioresource production and processing systems; water management and irrigation system design; spatial decision support systems for environmental protection and resource development; bioremediation; biological and thermochemical conversion; control, automation and mechanization of biological systems. Graduates of the program have entered careers in industry and public agencies or have undertaken further study in a PhD degree program. Intended candidates for the MS must present a bachelor's degree from an accredited engineering program or the equivalent.

Plan A Requirements

- Twenty-one (21) course credits and nine (9) thesis research credits.
- Directed Research (MBBE 699) and Thesis Research (700) cannot be used to satisfy course credit requirements
- Twelve (12) or more course credits must be at 600 level or above.
- Twelve (12) or more course credits must be in biological engineering; of these nine (9) must be earned in courses numbered 600-698.
- One graduate seminar in biological engineering or equivalent.
- Pass a final oral examination administered by a committee of three or more graduate faculty, chaired by the student's thesis advisor.
- Enrolled in the graduation semester. If all other course work is completed, one credit of BE 700 must be taken in the graduation semester.

Plan B Requirements

- Twenty-seven (27) course credits and three (3) credits of Directed Research (MBBE 699) on a design or research project.
- The Directed Research (699) cannot be used to satisfy course credit requirements.
- Eighteen (18) or more course credits must be at 600 level or above.
- Eighteen (18) or more course credits must be in biological engineering; of these twelve (12) must be earned in courses numbered 600-698.

- One graduate seminar in biological engineering or equivalent.
- Pass a final oral examination administered by a committee of three or more graduate faculty, chaired by the student's advisor.
- Enrolled in the graduation semester. If all other course work is completed, one credit of BE 500 must be taken in the graduation semester.

Contact Information

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Graduate Program in Molecular Biosciences and Bioengineering

The Molecular Biosciences and Bioengineering graduate program offers both MS and PhD degrees. The MBBE research and graduate training center around understanding the biochemical, nutritional, and molecular-biological processes that underlie growth, development, photosynthesis, and stress, especially as related to tropical agriculture, aquaculture, plant and environmental biotechnology, and bioengineering. Many MBBE graduate students are supervised and supported by cooperating and affiliate graduate faculty from John A. Burns School of Medicine, University of Hawai'i Cancer Center, Pacific Biomedical Research Center, Queens Medical Center, Hawai'i Agricultural Research Center, Oceanic Institute, Sea Grant College Program, School of Ocean and Earth Science and Technology, College of Engineering, and several departments including microbiology, zoology, human nutrition, food and animal sciences, and plant and environmental protection sciences.

Entrance Requirements

- Minimum qualifications for admittance as a regular student are an undergraduate degree from an accredited U.S. college or university or equivalent degree from a recognized foreign institution of higher learning and a GPA of at least 3.0 on a 4.0 scale.
- All prospective students must submit scores from the GRE General Test. In cases where foreign students encounter difficulty in taking the examination, submission of scores may be delayed with permission from the Graduate Division. Foreign students must also submit TOEFL scores (see Graduate Bulletin for exceptions.) A minimum TOEFL score of 250 in computer-based test or 100 in internet-based test is required.
- All applicants are expected to have completed courses or equivalents in physics, chemistry, basic biology, genetics, biochemistry, physiology, and one additional upper division course in cellular or molecular biology. While not a requirement, physical chemistry is highly recommended. Students may be accepted with deficiencies in one or more of these areas, however, deficiencies must be made up during the first year as a graduate student. Such courses may not be used for graduate credit.

General Guidelines and Requirements for MS Plan A

- Minimum course requirements: 12 credits of 600-level courses (not including MBBE 699), 6 credits of 400 level courses (not including 499), 6 credits of 699 and 6 credits of 700. Graduate students are encouraged to take one credit seminar (610 or equivalent) each academic year. They require at least one seminar credit for MS degree. The thesis proposal or defense seminar cannot be used to meet this requirement. All courses must be approved by the committee and the graduate chair.
- Two-page proposal. Like PhD students, MS students also need to discuss with their major advisors about their research projects and write a two-page proposal within the first semester.
- A thesis proposal seminar: MS students need to present their preliminary results and the plan of work in a proposal seminar. MS students who conduct research in laboratories outside the Mānoa campus may present their proposal seminars in their laboratory locations.
- Presentation at the CTAHR symposium. MS Plan A students must make at least one presentation in the CTAHR symposium. They are encouraged to make presentations in other national and international conferences.
- Thesis defense. MS Plan A students must present a public presentation of work in the final semester. Students should consult with their committee and the graduate chair for a convenient date for this presentation at the middle of the final semester.
- Publication. Students are encouraged to publish a paper before defense.

General Guidelines and Requirements for MS Plan B

- Minimum course requirements: 18 credits of 600-level courses (not including MBBE 699), 9 credits of 400 level courses (not including 499), 3 credits of 699. Graduate students are encouraged to take one credit seminar (610 or equivalent) each academic year. They require at least one seminar credit for MS degree. The final research presentation cannot be used to meet this requirement. All courses must be approved by the graduate chair.
- Research report, final presentation and oral exam. The Plan B students also do a research project for at least one semester. The results of this research should be written as a 'research report' and submitted to a committee composed of the research advisor, another faculty, and the graduate chair. The results also must be presented as a seminar in the final semester. At the end of the presentation, the committee will ask questions about the research project and other related subject. The written report should be about 10-20 pages, double space, and should contain the following sections: abstract (200-300 words), introduction (background and justification, 1-page), literature review (3-7 pages), objectives, materials and methods (3-7 pages), results and discussion (3-10 pages), and references. For graduation, a student must obtain satisfactory grades in the research report, oral presentation, and the oral exam.

General Guidelines and Requirements for PhD Degree

- A temporary committee: graduate chair appoints a temporary committee for each PhD student. The committee comprises

the student's supervisor (major advisor), graduate chair, and a faculty member. The committee advises on course work and other academic and research related matters.

- Course work. Students are required to take a minimum of three high-level courses and MBBE 401 (Molecular Biotechnology). The courses must be pre-approved by the major advisor and graduate chair. Graduate students are encouraged to take one credit seminar (610 or equivalent) each academic year. They require at least two seminar credits for PhD degree. The dissertation proposal or defense seminar cannot be used to meet this requirement.
- Two-page proposal. Students need to discuss with their major advisors about their research projects and write a two-page proposal. The proposal must be submitted to the graduate chair within the first semester. The proposal should have the following sections: (i) Introduction (background and justification), objectives, and approach. If the scope and objectives of the project are changed or modified later, the temporary committee should be informed and a copy of the revised proposal should be submitted to the graduate chair.
- Qualifying exam: PhD students have to take a qualifying exam within the first, second, or third semester. As a part of this exam, students are asked to write a manuscript from the results obtained within the first one or two semesters.
- Permanent committee: After completing the qualifying exam, a PhD student can form a permanent committee in consultation with his supervisor and the graduate chair.
- CTAHR Symposium: Students are encouraged to make a poster presentation in the CTAHR symposium in the first year. They must make a presentation in the second year and should continue to make presentations in subsequent years until graduation.
- Other presentations: Students are encouraged to make oral and poster presentations in other national and international conferences. A number of travel scholarships are available from the Graduate Student Organizations. Often the supervisors provide funds for student travel. Students can also make presentations in a number of research symposia organized at the UH Mānoa campus. These include Tester Symposium, Microbiology Symposium, and BioMed Symposium.
- The first manuscript: Students should try to complete the manuscript that was started as a part of the qualifying exam and get it published as soon as possible.
- Committee meetings: Students should meet at least once a year with the committee.
- Proposal seminar: There should be frequent discussion between the student and the major advisor about the progress and direction of research. When a student and the major advisor both agree that the project is going well and there are some good data, the student may be allowed to write a full proposal and then present a proposal seminar. All graduate faculty and students are invited to the proposal seminars. A proposal seminar must not be delayed beyond three years. If it is delayed beyond three years, the graduate chair will discuss with the committee and consider transferring the student to the MS program.
- Revision of dissertation proposal. Sometimes, a project may not go as expected and run into unexpected problems. Under such a situation, the project may have to take a new direction and some of the objectives may have to be modified. The student should invite a committee meeting and present a revised proposal.
- Comprehensive exam: It is an oral exam given by the committee and the graduate chair. The graduate chair or a representative appointed by him serves as the moderator for the exam. The committee will ensure that the student has learnt molecular biosciences or bioengineering and mastered the subject well. The comprehensive exam must not be delayed beyond three years. If it is delayed beyond three years, the graduate chair will discuss with the committee and consider transferring the student to MS program.
- Review of literature: The students are encouraged to conduct an extensive literature review related to his or her research subject. He or she should discuss with his or her supervisor about the main focus of the "review of literature" chapter of his or her dissertation. This must be completed and forwarded to the committee within the first three years.
- Publications: Publications are essential requirements of a PhD degree in MBBE. Students are encouraged to publish several papers in refereed journals. There must be at least one publication as the first author in a standard refereed journal. Only under an exceptional situation, where research subject is very problematic, and the supervisor assures and convinces the committee and the graduate chair that a publication is forthcoming, a student may be considered for graduation without a publication on the day of defense.
- Submission of dissertation to the committee: Students are encouraged to write and submit the 'Review of Literature' chapter to the committee well in advance, preferably one year before submitting the complete dissertation. They can also write the chapters 'Introduction' and 'Materials and Method' in advance. All chapters of the dissertation must be first submitted to and corrected by the major advisor before submitting to the rest of the committee. The committee members may refuse to read the chapters if these were not previously read, corrected, and approved by the major advisor.
- Final dissertation defense: The final dissertation defense seminar is perhaps the most important event for PhD. Therefore, a student must prepare well for this presentation. A student must get approval of the major advisor and the committee for presenting a defense seminar. The Graduate Division must be notified in advance by the student through the graduate chair about the date, time, and place of dissertation defense. Graduate faculty and students must be invited to the defense seminar.

List of Approved Courses for MBBE Graduate Students

All graduate students are encouraged to take MBBE 401 Molecular Biotechnology or an equivalent course as a prerequisite. The 600-level courses can be selected from the following list of courses. Students can select other courses after obtaining approval from the committee and the graduate chair.

- MBBE 601 Molecular Cell Biology
- MBBE 620 Plant Biochemistry
- MBBE 625 Biosensor Principles and Applications
- MBBE 650 DNA and Genetic Analysis

- MBBE 651 Signal Transduction and Regulation of Gene Transcription
- MBBE 683 Advance Bioinformatics Topics for Biologists
- MBBE 687 Advanced Lab Techniques
- BE 606 Instrumentation and Measurement
- BE 622 Experimental Methods in Cause-Effect Modeling
- BE 625 Biosensor Principles and Applications
- BE 634 Biological Treatment
- BE 638 Biosystems Modeling
- CMB 621 Cell Molecular Biology I
- CMB 622 Cell Molecular Biology II
- MICR 625 Advanced Immunology
- MICR 632 Advanced Microbial Physiology
- MICR 671 Bacterial Genetics
- PEPS 630 Plant Virology
- PEPS 646 Plant-Bacterial Interactions
- PEPS 681 Pesticide Toxicology
- TPSS 604 Advanced Soil Microbiology
- TPSS 614 Molecular Genetics of Crops
- TPSS 640 Advanced Soil Chemistry

Financial Assistance

All students in the MBBE program are currently supported through teaching assistantships, research assistantships, or fellowships. In addition, tuition is waived for all assistantships and most fellowships. It is recommended that students interested in research assistantships contact faculty working in their area of interest regarding availability. Additional fellowship support is available from the East-West Center, which offers scholarships to Asian, Pacific, and American students for affiliation in one of their programs.

Contact Information

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Natural Resources and Environmental Management

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Web: www.ctahr.hawaii.edu/nrem/

Faculty

*C. Chan-Halbrendt, PhD (Chair)—agricultural and international development and environmental economics, marketing
*R. L. Bowen, PhD—natural resource policy, economics, sustainable agriculture
*G. L. Bruland, PhD—soil and water conservation, coastal resource management
*L. J. Cox, PhD—community economic development
*S. E. Crow, PhD—soil ecology and biogeochemistry
*C. I. Evensen, PhD—natural resource management, environmental quality
*A. Fares, PhD—tropical soil/watershed hydrology
*C. A. Ferguson, PhD—natural resource and environmental policy
*J. B. Friday, PhD—tropical forestry/agroforestry extension
*P. V. Garrod, PhD—marketing and production economics
*C. Gopalakrishnan, PhD—natural resource and environmental economics and policy
*T. W. Idol, PhD—tropical forestry/agroforestry
*J. J. K. Leary, PhD—invasive species control
*C. Lepczyk, PhD—ecosystem management, wildlife ecology, landscape ecology
*P. Leung, PhD—production, fisheries, aquaculture
*C. M. Litton, PhD—forest ecosystem ecology, biogeochemistry
*T. Miura, PhD—geospatial analysis, remote sensing
S. Y. Nagano, MS—4-H youth program, county extension
J. Tsend-Ayush, PhD—remote sensing of global vegetation
*J. F. Yanagida, PhD—production economics, price analysis, international trade

Cooperating Graduate Faculty

K. M. Burnett, PhD (SSRI)—invasive species assessment and management
J. DeFrank, PhD (TPSS)—herbicide management
A. El-Kadi, PhD—groundwater hydrology
T. Giambelluca, PhD—climatology, hydrology
M. Habte, PhD (TPSS)—soil ecology, microbiology
N. V. Hue, PhD (TPSS)—organic cycling
P. S. Leung, PhD—production, fisheries, aquaculture
Q. Li, PhD (MBBE)—environmental chemistry
C. Ray, PhD (CEE)—ground water hydrology and chemistry
T. Radovich, PhD (TPSS)—sustainable farming
G. Uehara, PhD (TPSS)—systems simulation in agriculture
H. Valenzuela, PhD (TPSS)—vegetation physiology and management

Affiliate Graduate Faculty

J. Fox, PhD (East-West Center)—social forestry
R. Mackenzie (USDA Forest Service)—aquatic ecology
M. Pan (NOAA Fisheries)—fishery economics
S. Pooley, PhD (NMFS)—marine resource economics
M. Walker, PhD (Univ. of Nevada, Reno)—water quality, microbiology

Degrees and Certificates Offered: BS, MS, and PhD in natural resources and environmental management, and Graduate Resource Management Certificate (See the "Interdisciplinary Programs" section within the *Catalog*)

The Academic Program

The Natural Resources and Environmental Management (NREM) program emphasizes the science and management of natural resources and their interlinks to environmental quality. It provides students with scientific knowledge of the physical, chemical, biological, economic, social, and policy elements of natural resources management and allows them to understand the principles that underpin productive, sustainable natural resource use, and enhanced environmental quality. Graduating students will be able to solve contemporary resource use

* Graduate Faculty

problems and assist in sound decision making for optimizing land use and managing agricultural and forestry systems, watersheds, coastal ecosystems, and landscapes in an ecologically sound manner. Graduates will also be skilled in addressing resource and environmental policy issues and the needs of diverse stakeholders and communities including policy makers and planners. Scientific objectivity will be emphasized as an important element of environmental planning. Thus, students will be trained in the use of quantitative models and such tools as decision aids for optimizing natural resource management and ecosystem stewardship.

Undergraduate Study

BS in Natural Resources and Environmental Management

The bachelor of science degree in natural resource and environmental management is a science-based interdisciplinary degree emphasizing the management of natural and environmental resources, that is, decision-making and actions to modify the resource base in order to achieve specified goals. The focus is on tropical island ecology and terrestrial and coastal ecosystems, with special consideration given to Hawai'i's unique physical and social environment. The program gives students the ability to conceptualize and critically analyze environmental problems, identify management options, implement suitable interventions, and evaluate their effectiveness. Students receive comprehensive training in basic and applied natural and social sciences, management skills and techniques, and real-life problem-solving including community experiences. Students also develop an individual specialization in an upper division study area of their choice. Graduates have challenging and rewarding career opportunities with government agencies, non-profit organizations, and private businesses in resource-based industries and environmental protection. The BS degree also provides solid academic preparation for post-baccalaureate professional training and graduate study in natural resources and related environmental fields.

Advising

Undergraduate majors are required to report for advising prior to registration each semester. An entering student must meet with the undergraduate program chair to determine the student's interest and preparation for the NREM major. The student is then assigned to an advisor, with whom he or she meets every semester to plan courses and chart progress toward graduation. After a student decides on a track specialization, the advisor assists the student in arranging an internship (NREM 492), selection of elective courses, career advising, and his or her professional development.

Entrance Requirements

Freshmen may be admitted directly into the program when they apply to UH Mānoa. Students transferring from another program in the UH System or other universities must have a minimum 2.5 GPA for transferable credits.

Degree Requirements

The BS degree requires a total of 128 credit hours, with at least 60 credits in upper division and non-introductory (i.e. 200-level with college-level prerequisite). Regardless of selected specialization, all students must complete a set of basic core courses. Many of these courses also satisfy General Education Core requirements. Required basic courses include:

- GEOG 101/101L
- CHEM 151/151L or 161/161L
- BIOL 171/171L and 172/172L
- One course from MATH 203, 215, 241, or NREM 203

All students must also complete an applied science program core, which requires the following courses:

- NREM 210
- NREM 220 or ECON 130
- NREM 301/301L, 302, and 310
- NREM 492 and 494

Specializations and Their Requirements

Students have a choice between two tracks within which to develop an upper-division specialization. Both tracks require a set of specific courses and selected electives totaling 30 credits. Some electives, however, may require additional prerequisite courses and credits.

Specialization in Resource Management and Conservation

This track focuses on the biological/physical and natural science aspects of resource management. Course requirements include:

- PHYS 151/151L
- CHEM 162/162L
- NREM/TPSS 304
- NREM 477
- 18 upper division credits in a natural resource specialization area, with at least one course that emphasizes analytical lab, or field research methods (course selection requires advisor approval).

For information on a Bachelor Degree Program Sheet, go to www.manoa.hawaii.edu/ovcaa/programsheets/.

Specialization in Resource Development and Policy

This track emphasizes the social sciences and business/public management skills. Course requirements include:

- NREM 341 or 351
- FAMR 352 or NREM 420
- One course from MBBE/TPSS/ECON 429, NREM 458 or 477, or GEOG 413
- 12 upper division credits from social science disciplines, such as anthropology, economics, geography, political science, or sociology. At least 9 credits must be in a single discipline with no more than one course from a closely related multidisciplinary social science program (course selection requires advisor approval)
- 3 upper division credits in social science analytical/field research methods or in advanced communication (COM, JOUR, SP)
- 9 upper division credits in specific natural resource area(s) or field study methods

For information on a Bachelor Degree Program Sheet, go to www.manoa.hawaii.edu/ovcaa/programsheets/.

Options for Meeting UH Mānoa Hawaiian/Second Language Requirement

As part of the graduation requirements for all undergraduate students at UH Mānoa, NREM majors will select one of the following three options for Hawaiian/Second Language study, in consultation with the faculty advisor:

Option 1: Show proficiency in Hawaiian/Second Language at a 202 course level. Native and bilingual speakers of a second language may be granted a waiver for the foreign language requirement by the College of Languages, Linguistics, and Literature.

Option 2: Show proficiency in Hawaiian/Second Language at a 102 course level and take one additional course each in the Social Sciences (3 credits) and in the Natural Sciences (3-4 credits).

Option 3: Take two additional courses each in the Social Sciences (total 6 credits) and in the Natural Sciences, including at least one course with a laboratory (total 7-8 credits). The additional Social and Natural Science courses can be chosen from any 100-200 level UH Mānoa courses in the respective area but cannot be used to meet other UH Mānoa general education requirements (except focus) or NREM major requirements.

Graduate Study

NREM offers the following graduate degrees and certificates: MS (Plans A, B, and C), and PhD degrees in Natural Resources and Environmental Management, and a university-wide Graduate Resource Management Certificate. Several NREM faculty also participate in a campus-wide graduate degree specialization in Ecology, Evolution, and Conservation Biology, to which incoming or continuing students may apply.

The NREM graduate program brings together natural and social scientists to offer an integrative and inter-disciplinary program that uses a system approach to understand and manage tropical and sub-tropical terrestrial and aquatic ecosystems. Emphasis is placed on island settings and their relevance to managing land and seascapes. Studies in NREM incorporate the various components and scales (spatial and temporal) that determine ecosystem structure and function, and that bear upon the social and economic welfare of residents in diverse communities and environmental settings. Curricula and courses emphasize the application of physical, biological, and social sciences to the sustainable management and conservation of natural, environmental, and economic resources. The program also provides a science-based foundation to assess the processes that control the structure and function of terrestrial and aquatic ecosystems, and the human behaviors and policies that impact those processes.

Students are expected to acquire quantitative reasoning, critical thinking, and other advanced skills that enable them to solve contemporary resource use and environmental problems and to assist in sound policy development and implementation. NREM graduates are skilled in addressing natural resources and environmental policy and management issues of the competing needs of diverse clientele and communities. Students are trained in the application of quantitative models to optimize the use and management of natural resources.

Natural resource and environmental management issues are attracting considerable national and global attention, as well as growing donor interest, especially in the Asia/Pacific and tropical and subtropical regions. Graduate training, therefore, features collaboration with national and international institutions to foster programs that provide students with opportunities to learn about the ways in which people from other countries and cultures manage their natural resources and interact with their environments. NREM has a diverse mix of domestic and international graduate students.

Graduating students are expected to serve as leaders and professionals in natural resources and environmental management and policy, academic teaching and research, and applied research and extension in educational and governmental institutions, international, national, and state technical assistance and policy agencies, agricultural and forestry industries, consulting firms, and private nonprofit and non-governmental organizations.

To underscore its integrative and global nature, the NREM Graduate Program features strong collaboration with other academic departments within and outside of CTAHR, as well as selected collaborating institutions in and outside of Hawai‘i such as transitional economies in Asia, eastern Europe, and the Middle East. In addition, cooperating and affiliate graduate faculty in NREM complement and supplement departmental expertise.

Specialization Areas

NREM is an interdisciplinary department that offers integrative graduate curricula necessary for quality decision-making and solution-oriented natural resource and environmental management. As a foundation for graduate training, all NREM students are expected to acquire a common base of knowledge embodied in a set of core courses. Beyond that, students are expected to develop knowledge and skills within a chosen specialization area. This helps to ensure that students have the real-world skills needed to perform specific tasks, analyze resource management and policy issues, carry out original and meaningful research, and effectively perform outreach educational activities.

Examples of specialization areas include, but are not limited to: aquaculture economics and management; coastal watershed management; contaminant hydrology; contaminant sources and transport in watersheds; ecological and environmental economics; economics of sustainable resource utilization; fishery economics and management; forest economics; forest ecosystem management; integrated resource management; irrigation and water management; land and water use policy assessment; land degradation processes and models; land resource inventory and interpretation; land, soil, and water conservation reclamation and remediation; landscale ecology; natural resource and environmental non-market valuation; restoration ecology; remote sensing and geospatial analysis; sustainable community economic development; sustainable land and resource management; tropical forestry and agroforestry; water quality; and watershed hydrology.

The student’s advisor and thesis/dissertation committee will assist in choosing appropriate coursework and research or other activities to develop a specialization area. Students are

expected to achieve this by the completion of their first year in the department.

Admission and Deficiencies

Regular, probationary, and conditional status is determined based on student's academic performance at the time of application. If you are admitted as regular status, you may start your formal graduate program immediately. If you are admitted as probationary or conditional status, you have specific criteria that must be fulfilled such as a BS or MS degree, course deficiencies, GRE (expected minimum GRE score of 1,100), or other documents. These criteria are specified in your letter of acceptance, and should be discussed immediately with your advisor. It is expected that a student will move from probationary and/or conditional status to regular status by the end of their first year by completing Form I. Applicants for the MS degree are required to have a BS or equivalent degree and applicants for the PhD degree are required to have an MS or equivalent degree.

The minimum required TOEFL score (for foreign applicants only) is: (a) MS student: 550, 213, or 80 for paper-based, computer-based, or internet-based examinations, respectively; and (b) PhD student: 600, 250, or 100 for paper-based, computer-based, or internet-based examinations, respectively. The TOEFL requirement applies to all foreign students, except those who are native speakers of English from Australia, United Kingdom, Canada, New Zealand, or Singapore. In addition, students who have received a bachelor's degree or an advanced degree from an accredited/recognized college within the last five years in the U.S., U.K., Canada, New Zealand, Singapore, or Australia are exempt from the TOEFL requirement. Students with weak TOEFL scores are required to enroll in remedial ELI (English Language Institute, www.hawaii.edu/eli/index.html) courses.

NREM requires prior completed coursework that is equivalent to or higher than NREM 203, 220 (or ECON 130), 310, CHEM 151/L, and BIOL 171/L. Students who do not have coursework in one or more of these areas may be accepted into the program, but will be required to make up course deficiencies within their first 1-2 semesters.

Advising

Admitted students will check in with NREM staff, his/her advisor, or the graduate chair as soon as possible. An advisor will be identified for every student based on the student's interest, with the consent of the advisor. The primary responsibilities of the advisor during your first semester are to verify entrance and background deficiencies, prescribe remedial courses as early as possible in the student's program, and provide guidance in course selection. All of these items should be completed by the end of the student's first year. Submit Form I to the graduate chair upon fulfilling all deficiencies. If there are no deficiencies, Form I should be submitted at the beginning of the first semester.

Degree Requirements

MS in Natural Resource and Environmental Management

NREM offers three options for the MS degrees: Plan A is a thesis-driven research degree, and a student will be accepted into this plan if a faculty sponsor has agreed to advise the student; Plan B is a course driven, professional degree that also requires an integrating capstone experience; and Plan C is only for students with exceptional prior work experience that requires a minimum of two semesters of fulltime resident study at UH Mānoa and a final written and oral comprehensive examination.

Once admitted, MS students must select a specialization (Plan A) or concentration (Plan B) area with the approval of their advisor. To meet the integrative, interdisciplinary intent of the NREM program, a set of graduate level courses, (the Primary MS Core) will be required of every student, regardless of his/her selected Plan option or specialization area.

To meet the integrative, interdisciplinary intent of this program, a set of graduate level courses, a Primary MS Core, will be required of each MS student regardless of his/her Master's degree plan. The course requirements for each plan are:

Plan A

Primary MS Core (9 credits): NREM 600 Evaluation of Natural Resources Management (3); 601 Economic Analysis of Natural Resource Management (3); 605 Research Skills (2); 701 Research Seminar (1)

Electives (15 credits): Course in graduate research methods (3); NREM graduate courses (6); Other graduate courses for specialization from within or outside of NREM (6); a maximum of 6 credits of upper-division undergraduate course credits (400-level) allowed

Thesis Option (6 credits): NREM 700 Thesis (6)

Plan B

Primary MS Core (9 credits): Same as Plan A.

Research Methods (3 credits): course in graduate research methods (3).

Concentration Areas (total 18 credits): Select a concentration area from the following: Geospatial Analysis and Modeling, Natural Resources Economics and Environmental Planning, Land and Water Resource Management, and Applied Terrestrial Ecology. They are required to take a minimum of 9 credits from their concentration area and 3 credits from each of the other areas. The list is not comprehensive, and substitutions will be considered at any time via a petition by a faculty advisor to the graduate committee.

Capstone Experience (6 credits): NREM 695 MS Plan B Capstone (6) is required. Typical capstone experiences involve: (a) internship/coop/special field experience; (b) investigation of a special topic; and/or (c) development of a project, directed readings/study, or a research project. See wwww.ctahr.hawaii.edu/nrem/students/masters.html for more details.

Plan C

Students with exceptional prior work experience. Requirements include residence for two semesters of full-time study, a minimum of 18 graduate credit hours, and a final examination (written and oral). This option is only available to students who are mid-career professionals, having at least 5 years of relevant work experience in natural resources and environmental management.

Primary MS Core (9 credits): Same as Plan A.

Electives (9 credits): NREM graduate courses (with no more than 3 credits of NREM 699)

PhD in Natural Resource and Environmental Management

The PhD degree in NREM is awarded only to students with outstanding scholarly achievement. Applicants for the PhD program are expected to have an MS degree. However, PhD standing may be provisionally granted to applicants with a BS degree if they have a strong academic record (i.e., Honors), research experience (i.e., prior scientific publication(s)), and high GRE scores. These applicants may still be required to obtain an MS degree in NREM before formal admission to PhD candidacy. Those with academic records that do not match NREM core requirements will be expected to incorporate these into their PhD program. In addition, to meet the integrative, multi-disciplinary intent of this program, a set of graduate level courses (Primary PhD Core) will be required of every student, regardless of his/her selected specialization area. In addition, a set of electives will also be required. These electives are meant to provide background in research methods and depth in the student's specialization area. The remaining degree requirements will be met by dissertation credits (NREM 800). All PhD students must pass a written and oral Comprehensive Examination (described below) before being advanced to candidacy. The student's dissertation committee is responsible for designing and administering the Comprehensive Examination.

Primary PhD Core (7 credits)

- NREM 611 Resource and Environmental Policy (3)
- NREM 612 Predicting and Controlling Degradation in Human-Dominated Terrestrial Ecosystems (3)
- NREM 701 Research Seminar (1)

Electives (24 credits)

- Graduate research methods (6)
- NREM graduate courses (9)
- Other graduate courses for specialization from within or outside of NREM (9); a maximum of 6 credits of upper-division undergraduate course credits (400-level) allowed
- from within or outside of NREM (9)

Dissertation (1 credit)

- NREM 800 Dissertation Research (1)

Comprehensive Examination

PhD students must pass a two-part (written and oral) Comprehensive Examination upon completion of the majority of the required core courses and electives. The final outcome of the comprehensive examination is the acceptance of the student to the Doctor of Philosophy candidacy in NREM. Based on this examination, the student's committee will determine if the student: (a) is ready, (b) needs to take more courses to remediate deficiencies in her/his training, or (c) that the student is not fit for the doctoral degree program. In the process of administering the examination, the committee will test the rigor of the student's training as: (a) a scientist in NREM (has in-depth knowledge of what makes him/her unique compared to other graduates of UH that might have similar interests; in other words, a NREM student focusing on hydrology should not only be trained to deal with a hydrology problem but also should be able to address the natural resources and environmental management implications of that problem as compared to a hydrology graduate from Civil and Environmental Engineering or Geology and Geophysics or Geography), and (c) a scientist in her/his specialty area (for example, a NREM PhD student with a specialty in hydrology should have more in-depth expertise in hydrology than other NREM PhD students working in other specialty areas

Based on this understanding, the comprehensive examination questions can cover: (a) his/her specialty (i.e., hydrology, forest ecology, and management), (b) general topics related to NREM (i.e., core courses, background knowledge), (c) knowledge of general research methods (i.e., statistics, analysis methods, etc.), and (d) proposed dissertation research.

Plant and Environmental Biotechnology Program

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Biotechnology Area Advisory Committee

H. Ako, PhD (Coordinator)—biochemistry, aquaculture
A. M. Alvarez, PhD—bacterial diseases
D. Borthakur, PhD—molecular genetics of bacteria and their interactions with plants
D. A. Christopher, PhD—plant molecular biology, regulation of gene expression
R. M. Manshardt, PhD—tropical fruit breeding and genetics

Participating Faculty

J. S. Hu, PhD—transgenetic disease resistance
D. Jenkins, PhD—biosensors
C. M. Kinoshita, PhD—bioremediation
A. R. Kuehnle, PhD—genetic engineering and tissue culture
P. S. Leung, PhD—biotechnology economics
Q. Li, PhD—environmental biochemistry
P. Nerurkar, PhD—metabolic disorders, signal transduction, alternative medicine
W. W. Su, PhD—cell culture, biochemical engineering

* Graduate Faculty

T. Sylva, PhD—bioremediation
A. Wieczorek, PhD—molecular systematics, public education on biotechnology
J. Yang, PhD—animal molecular biology and biotechnology
J. Zhu, PhD—plant and biotechnology transformation biotechnology

Degrees Offered: BS in plant and environmental biotechnology

Program Goals

- To provide education leading to biotechnology literacy;
- To provide training in the emerging field of biotechnology;
- To ensure training is broad based;
- To ensure students will be able to work as members of interdisciplinary teams; and
- To staff Hawai'i's emerging biotechnology industries.

The Academic Program

During the past decade, biotechnology has brought about major changes in agricultural sciences and society. The Plant and Environmental Biotechnology program (PEB) is designed to train undergraduate students for careers in new and growing areas of the life sciences emphasizing the use of biotechnology in agriculture, environmental clean-up and management, industry, teaching, and other professions. The program provides a strong foundation in molecular biology, biochemisty, genetics, biotechnology, and the life sciences. It serves as excellent and rigorous training for graduate and professional school.

Students tailor the major to meet their needs by choosing one of the specializations as their focus of study: environmental and microbial biotechnology, plant biotechnology, insect and pathogen biotechnology, general biotechnology, or aquaculture and bioreactor biotechnology. Students participate in hands-on laboratory courses culminating in research and a senior thesis. Students could work as genetic engineers developing more nutritious, pest resistant, or otherwise superior crops by genetic engineering. Students can learn molecular diagnostic methods such as PCR, DNA finger-printing, gene mapping, and protein analysis. They could also be restoring parts of the environment by bioremediation, working in the marine biotechnology industry, or entering graduate or professional school.

Undergraduate Study

BS in Plant and Environmental Biotechnology

Requirements

Students must fulfill the General Education Requirements of UH Mānoa and the college.

Among the courses they must include in these requirements are:

- PHYS 100/100L or 151/151L; 152/152L
- CHEM 161/161L; 162/162L; 272/272L
- BIOL 171/171L; 172/172L; 275/275L
- MATH 215 (Applied Calculus I) or 241 (Calculus I)
- NREM 220
- NREM 310 (Statistics in Agriculture and Human Resources)
- Foreign languages or options

In addition, students must complete the following major core requirements:

- MBBE/BIOL 304 (Biotechnology: Science and Ethical)
- ANSC 446 (Genes and Animal Biology) or PEPS/TPSS 371 (Genetics: Theory to Application)
- MBBE/BIOL 401 (Molecular Biotechnology)
- MBBE 402/402L (Principles of Biotechnology)
- MBBE/PEPS/TPSS 499 (Directed Research)
- MBBE/PEPS/TPSS 499 (Senior Thesis)

Finally, students must specialize in one of the five options below. They must take the courses indicated.

The **Environmental and Microbial specialization** prepares students for employment in teaching, industry, and government activities dealing with environmental monitoring, clean-up, and quality. The specialization also prepares students for graduate education in the environmental sciences.

Required Courses

- CHEM 272/272L (Organic Chemistry I)
- MICR 351/351L (Biology of Microorganisms/Lab)
- MBBE 412 (Environmental Biochemistry)
- MICR 485/485L (Microbes and Their Environment)
- 15-19 credits from among GEOG 101/101L, CHEM 274/274L, PEPS 405, BIOL/MBBE 406 and BIOL 406L, BE 431, MICR 431/431L, MICR 461/461L, MICR 475/475L, MBBE/PEPS/TPSS 499 additional credits beyond 3

The **Plant Biotechnology specialization** uses the tools of molecular biology, genetics, and tissue culture to learn how plant cells work and to develop plants with improved traits. The specialization prepares students to enter the plant and agricultural biotechnology industries, various government agencies, or to pursue an advanced professional degree or a teaching career.

Required Courses

- PEPS 405 (Plant Pathogens and Diseases)
- TPSS 440 (Tissue Culture/Transformation)
- TPSS 453 (Plant Breeding and Genetics)
- BOT/TPSS 470/470L (Plant Physiology)
- 13 credits from among BIOL 265/265L, MET/OCN/OEST 310/310L, BOT 410, MBBE/PEPS/TPSS 499 additional credits beyond 3

For information on a Bachelor Degree Program Sheet, go to www.manoa.hawaii.edu/ovcaa/programsheets/.

The **General Biotechnology specialization** is for students who want a broader background covering a variety of different areas of biotechnology. This specialization will prepare students for careers in industry and government but may also be the best preparation for teaching or pursuing advanced graduate and professional degrees.

Required Courses

- BIOL 406/406L (Cellular Biology)
- BIOL 407 (Molecular Biology)
- 18 credits from among CHEM 273/273L, MET/OCN/OEST 310/310L, MICR 351/351L, TPSS 440, ANSC/OCN 450, TPSS 453, MICR 461, MICR 475, MICR 485/485L, MBBE/PEPS/TPSS 499 additional credits beyond 3

For information on a Bachelor Degree Program Sheet, go to www.manoa.hawaii.edu/ovcaa/programsheets/.

The **Insect and Pathogen specialization** prepares students for academic or industrial careers that integrate the traditional disciplines of entomology and plant pathology. The goal is to develop environmentally safe technologies to protect plants and agriculture from pest and pathogen attack.

Required Courses

- PEPS 363 (General Entomology)
- PEPS 405 (Plant Pathogens and Disease)
- PEPS/MBBE 412 (Environmental Biochemistry)
- PEPS 421 (Foundations of Pest Management)
- 13-14 credits from among MBBE/PEPS/TPSS 499 additional credits beyond 3

For information on a Bachelor Degree Program Sheet, go to www.manoa.hawaii.edu/ovcaa/programsheets/.

The **Aquaculture and Bioreactor specialization** prepares students to participate in the increasingly technology-driven areas of bio-based industries such as aquaculture, marine biotechnology, and large-scale production of valuable organisms and compounds for the agricultural, food, pharmaceutical, and medical industries. The specialization prepares students to enter commercial, university, or government jobs directly, to become entrepreneurs, or to continue on for further graduate training.

Required Courses

- ZOOL 320/320L (Vertebrate Zoology)
- BE 431 (Environmental Biotechnology)
- ANSC 446 (Genes and Animal Biology)
- 16-20 credits from among OCN 201, OCN 331, ZOOL 475/475L, MBBE/PEPS/TPSS 499 additional credits beyond 3

Plant and Environmental Protection Sciences

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Web: www.ctahr.hawaii.edu/peps/

Faculty

*B. S. Sipes, PhD (Chair)—nematology, alternative control methods
*A. M. Alvarez, PhD—bacterial diseases
*W. B. Borth PhD—plant virology, micoplasmas
*A. Bressan, PhD—insect vectors of plant pathogens
*Y. Cho, PhD—plant host pathogen interactions, molecular genetics of pathogens
R. H. Ebesu, MS—extension education (Kaua‘i Cooperative Extension Service)
*S. A. Ferreira, PhD—crop protection, extension education
*J. K. Grace, PhD—urban entomology, termite and social insect biology and control, insect behavior
R. T. Hamasaki, MS—fruit and vegetable crops extension education (Hawai‘i Cooperative Extension Service)
*A. H. Hara, PhD—horticultural entomology, post-harvest insect control, regulatory entomology (Beaumont Agricultural Research Center, Hilo)
*J. Hu, PhD—virology
*M. Kawate, PhD—pesticide registration
*P. Krushelnycky, PhD—entomology, invasion biology
*R. H. Messing, PhD—insect ecology and biological control (Kaua‘i Agricultural Research Center)
*S. C. Nelson, PhD—epidemiology, extension education (Beaumont Agriculture Research Center, Hilo)
*J. J. Ooka, PhD—diseases of coconuts, ‘awa, corn, soybeans, sunflowers, taro, ginger, medicinals, spices; disease suppressive composts (Kaua‘i Agricultural Research Center)
*D. Rubinoff, PhD—insect systematics and ecology, invasive species, conservation biology
D. M. Sato, MS—extension education (Hawai‘i Cooperative Extension Service)
*D. Sether, PhD—plant virology
K. T. Sewake, MS—extension education (Hawai‘i Cooperative Extension Service)
R. Shimabuku, MS—vegetable crops production and disease management extension education (Maui Cooperative Extension Service)
*H. Spafford, PhD—integrated pest management, biological control
J. S. Sugano, MS—extensions education (O‘ahu Cooperative Extension Service)
*J. Y. Uchida, PhD—fungal pathology, biological control of diseases, environmental impacts
*E. Villalobos PhD—entomology, insect ecology
*K. H. Wang, PhD—nematology, ecological pest management
*M. G. Wright, PhD—integrated pest management, tropical fruits and nuts, insect ecology, biological control
*J. R. Yates III, PhD—urban pest management, termite biology and control

Cooperating Graduate Faculty

L. Arita-Tsutsumi, PhD—insect behavior, honeybee ecology (UH Hilo)
D. Borthakur, PhD—molecular biology
K. Y. Kaneshiro, PhD—systematics, evolution, insect behavior
M. Shintaku, PhD—virology (UH Hilo)

Affiliate Graduate Faculty

J. W. Armstrong, PhD—commodity quarantine treatments, fruit fly control (USDA-ARS, Hilo)
R. Cabos, PhD—nematology (USDA-ARS, Hilo)
N. Evenhuis, PhD—systematics of *Diptera* (Bishop Museum)
P. A. Follett, PhD—commodity quarantine treatments, tropical tree fruit IPM (USDA-ARS, Hilo)
D. Gonsalves, PhD—plant virology (USDA-ARS, Hilo)
C. R. R. Hooks, PhD—entomology (University of Maryland at College Park)
F. G. Howarth, PhD—systematics (Bishop Museum)
E. B. Jang, PhD—insect physiology, fruit fly control (USDA-ARS, Hilo)
L. Keith PhD—phytobacteriology (USDA-ARS, Hilo)
D. O. McInnis, PhD—insect genetics (USDA-ARS)
N. J. Reimer, PhD—ant biology and control, biological control of weeds (Bishop Museum)

* Graduate Faculty

S. Schenck PhD—plant pathology (HARC)
R. I. Vargas, PhD—ecology, mass-rearing techniques (USDA-ARS, Hilo)

Degrees Offered: BS in plant and environmental protection sciences, MS in entomology, MS in tropical plant pathology, PhD in entomology, PhD in tropical plant pathology

The Academic Program

Agriculture, urban, and natural environments are severely affected by invasive plants and animals, arthropods, and disease causing organisms. Management of these pests and pathogens is essential to preserve the economic and ecological future of Hawai'i and the Pacific Basin. Societal concerns about protecting our natural resources and the environment have resulted in a plant and resource protection focus stressing biological control, integrated pest management, and genetically based methods. Hawai'i's location in the Pacific basin provides students with an ideal setting for tropical and environmental studies. The unique island ecosystem also encompass many cropping niches from humid tropical environments to arid temperate conditions. In addition, the multitude of agricultural and landscape plants produced provides a natural laboratory to study a diversity of urban and agricultural inputs. The multicultural aspect of the human population further adds to the intriguing plant, human, and pest interactions that are a part of the PEPS academic and research program. Students are presented with great educational opportunities to understand plant and environmental protection and pest management. Students will be prepared for employment in agricultural and urban pest management, science education, government, industry, and environmental resource management. Undergraduate students will be well prepared for professional and graduate studies.

Affiliations

Studies in Plant and Environmental Protection Sciences (PEPS) at UH Mānoa are strengthened by cooperative relationships with the following units: multidisciplinary graduate programs of the Cell, Molecular, and Neurosciences; Ecology, Evolution, and Conservation Biology Program; Harold L. Lyons Arboretum; Hawai'i Agriculture Research Center; B. P. Bishop Museum; Agricultural Research Service of the United States Department of Agriculture; Animal and Plant Health Inspection Service of the U.S. Department of Agriculture; and Hawai'i Department of Agriculture.

Advising

Students are assigned an academic advisor upon acceptance into the PEPS program. Undergraduates are required to consult with their advisor prior to registration each semester.

Undergraduate Study

BS Degree

PEPS is a multidisciplinary science degree that promotes the understanding of complex agricultural and urban problems created in the global ecosystem. Students receive interdisciplinary exposure to entomology, plant pathology, weed science, and environmental science and can focus on one of these areas in their upper division studies. This holistic program is developed so each student has the opportunity to learn pest management, crop protection, biotechnological approaches, environmental regulations, toxicology, and rural and urban sociology as these relate to their focus areas.

The instructional program is structured to achieve the following student learning outcomes: (1) students will demonstrate growth in the ability to analyze and communicate an environmental issue; (2) students will recognize and be able to explain the biology of at least 10 insect orders; (3) students will recognize and be able to describe biology and management methods for at least five significant plant pathogens in each category: fungi, viruses, bacteria, nematodes; (4) students will be able to describe the biology and damage of at least five invasive insects, pathogesn, or plants (weeds), and explain the limitations and implications of control strategies; (5) students will be able to explain and provide examples of economic injury level and threshold based pest management options; (6) students will demonstrate ability to apply skills learned to a real world situation or employment experience and effectively describe the experience; (7) students will demonstrate the ability to clearly communicate the results of self analysis and critical thinking.

Requirements (128 credit hours)

PEPS offers a flexible and individualized degree program that allows students to select among several different options to fulfill university core requirements. In accord with their own particular interests and in consultation with their advisor, students also choose from a variety of departmental courses and general electives. PEPS 499 (Independent Research) is a unique requirement that provides students with the opportunity to work individually with faculty members throughout their program.

Specific requirements are:

- ENG 100
- HIST 151, 152
- CHEM 161/161L, 162/162L
- BIOL 171/171L or BOT 101/101L or ZOOL 101/101L
- NREM 310 or FAMR 380/380L
- PEPS 210 or 250
- PEPS 363, 405 and 495; 2 courses numbered from 200 to 399; 6 credits of 499; and 15 credit hours of courses numbered from 400 to 499.
- 29 additional credit hours of approved electives based upon students' academic interests.
- Additional credit hours as necessary to meet UH Mānoa General Education Requirements.
- Hawaiian/Second Language Requirement: Undergraduate students in PEPS, in consultation with their undergraduate advisor, will be asked to select one of the following three options:
  Option 1: Show proficiency in a Hawaiian/Second Language at the 202 level;
  Option 2: Show proficiency in a Hawaiian/Second Language at the 102 level, and take one additional 3-credit semester course in the Social Sciences and one additional 3 or 4-credit semester course in Natural Sciences;
  Option 3: Take two additional 3-credit semester courses in Social Sciences and two additional 3 or 4-credit semester

courses in Natural Sciences. One of the courses in the Natural Sciences must include a laboratory.

The Social Science and Natural Science courses chosen can be any 100 or 200 level course offered at UH Mānoa in those areas.

Prospective majors should consult with the department to design an appropriate curriculum tailored to their interests.

For information on a Bachelor Degree Program Sheet, go to www.manoa.hawaii.edu/ovcaa/programsheets/.

Graduate Study

Entomology

MS and PhD degrees are offered in the entomology program. Courses are offered in biological control of insect and weed pests, insect ecology, insect physiology, insect transmission of plant pathogens, pest management, systematics, urban entomology, and tropical pest management. Thesis and dissertation research can be selected from any of these subject areas.

Students applying for graduate programs in entomology are expected to have acquired a bachelor's degree with credit hours in entomology and biology, including general biology, general entomology, integrated pest management; one year of chemistry; and an appropriate course in mathematics and/or statistics. Deficiencies in undergraduate preparation can be satisfied during the graduate program. Applications for admission must include GRE scores. The statement of objectives submitted with your application should describe your goals and interests in entomology. Applicants should also arrange to have three confidential letters of reference sent directly to the graduate program chair.

The MS and PhD degrees in entomology are recognized by the Western Interstate Commission for Higher Education (WICHE) regional graduate programs. Residents of Alaska, Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, Utah, Washington, and Wyoming are eligible, upon admission, to enroll at Hawai'i-resident tuition rates.

Master's Degree

The MS degree program is offered under either Plan A (thesis) or Plan B (non-thesis). A total of 30 credit hours are required for each degree option. An advisory committee composed of at least three members of the graduate faculty provides guidance to the student. For a general description of these options, see "Requirements" for each option.

The program provides an education in general knowledge of entomology, including basic principles of insect identification, biology, and control and prepares the student for employment in private industry, government agencies, and research institutions. Expected student learning outcomes are: (1) acquire and demonstrate competency/skills as a biologist; (2) acquire and demonstrate entomological knowledge necessary for professional success; and (3) acquire and demonstrate communication and literacy skills.

Tropical plant pathology has three student learning outcomes. Students in the program will communicate effectively; write and defend a thesis of original phytopathological research; present findings of their research in oral and/or poster formats in scientific forums; publish the results of their research in peer-reviewed journals; and assist others in learning plant pathology. Students are competent and knowledgeable biologists. They demonstrate this competency by having a basic understanding of molecular biology and genetics; with a general knowledge of the four major pathogen groups, by possessing understanding of plant disease epidemiology; having strong knowledge of their specialized field of study; and conducting research in plant pathology. Students will propose and formulate research objectives to address relevant plant pathological questions; and will conduct research using appropriate design and methods.

MS Plan A (Thesis)

- 16 credit hours of course work including seminars
- 2 credit hours of PEPS 690 Seminar in Entomology
- 12 credit hours of PEPS 700 Thesis Research
- 2 credit hours of PEPS 799 Proposal/Defense Seminar (CR/NC)
- Final oral defense and submission of acceptable thesis

MS Plan B (Non-thesis)

Students preparing for a career in research or admission to a doctoral program are advised to enroll in MS Plan A (thesis).

- 23 credit hours of course work including seminars
- 2 credit hours of PEPS 690 Seminar in Entomology
- 1 credit hour of PEPS 799 Proposal/Defense Seminar (CR/NC) during the semester in which a proposal for the directed research project is given.
- Final defense of the directed research project and examination on other aspects of entomological training before the advisory committee.

Doctoral Degree

Intended candidates for the PhD program should have earned the MS degree in entomology or equivalent from a recognized institution. Those with a BS or BA may petition for admittance into the PhD program only after enrolling in the MS program.

The goal of the PhD program is to have students possess broad general knowledge in all areas of entomology, in-depth knowledge in at least one area of specialization and develop the capability for independent research. Employment options for PhD graduates are in teaching, research, and extension at universities and in research, consulting, or management with private industries and government agencies. Expected student learning outcomes are: (1) acquire and demonstrate competency/skills as a biologist; (2) acquire and demonstrate entomological knowledge necessary for professional success; and (3) acquire and demonstrate communication and literacy skills; and (4) demonstrate the ability to apply creative and critical thinking in the independent development and conduct of research.

Requirements

- 3 credit hours of PEPS 690 Seminar in Entomology
- 2 credit hours of PEPS 799 Proposal/Defense Seminar (CR/NC)
- 1 credit hour of PEPS 800 Dissertation Research during semester of graduation
- Additional course work as determined by the doctoral advisory committee

- Oral, or oral and written comprehensive examination administered by the doctoral committee.
- Final oral defense of the dissertation research and submission of an acceptable dissertation.

Tropical Plant Pathology

Plant pathology is the study of plant diseases, their causes, and the interactions with the environment. The primary thrust in the program focuses on agricultural crops of economic importance; however, opportunities exist for discovery research in natural ecosystems and the laboratory. The field consists of several sub-disciplines including phytomycology, plant virology, bacteriology, nematology, epidemiology, crop protection, and molecular biology of host-pathogen interactions.

Students should have their undergraduate preparation in botany, horticulture, agronomy, microbiology, or plant and environmental protection sciences. Plant pathology has its foundation in biology and agriculture and offers wide opportunities in both basic and applied areas of biology, plant sciences, and agriculture. The tropical plant pathology program at UH Mānoa offers students a unique opportunity to gain knowledge of plant diseases on a vast diversity of tropical crops and native plants as well as the impacts of plant protection practices on the environment.

Please see the Graduate Education website for general graduate admissions requirements and procedures. Applications for admission must include GRE scores for verbal and quantitative aptitude. Candidates may need to demonstrate evidence of adequate preparation in other subject areas as well. Deficiencies may be corrected during the graduate program. In addition, applicants must (1) submit a Statement of Objectives describing their goals and interests in plant pathology directly to the graduate program chair, and (2) arrange to have three confidential letters of reference sent directly to the graduate program chair.

Master's Degree

The MS degree program is offered under either Plan A (thesis) or Plan B (non-thesis). A total of 30 credit hours are required for each degree option. An advisory committee composed of at least three members of the graduate faculty provides guidance to the student. For a general description of these options, see "Requirements" for each option.

The MS degree in tropical plant pathology provides a basic education and understanding of the pathogen groupings. Employment opportunities exist in industry, government agencies, research institutions, consulting, and farm management.

MS Plan A (Thesis)

- Research: 12 credits in PEPS 700 Thesis Research, and submission of acceptable thesis.
- Courses: 16 credits in courses approved by the candidate's committee, including 10 credits in courses numbered 600-698, excluding 660 and 699, including at least 6 credits selected from 616, 630, 646.
- Seminars: Minimum of 2 credits in 660, which is required each semester except when enrolled in 799; 2 credits in 799 (CR/NC). CR/NC credits are not counted towards degree credit requirements.

MS Plan B (Non-thesis)

- Research: 6-9 credits in PEPS 699 Directed Research, preferably taken in 2-3 different laboratories.
- Courses: 19-22 credits in courses approved by the candidate's committee, including 16 credits in courses numbered 600-698, excluding 660 and 699, including at least 6 credits selected from 616, 630, 646.
- Seminars: Minimum of 2 credits in 660, which is required each semester except when enrolled in 799; 1 credit in 799 (CR/NC). CR/NC credits are not counted towards degree credit requirements.

Doctoral Degree

Intended candidates for the PhD program should have earned the MS degree in plant pathology or equivalent from a recognized institution. Those with a BS or BA may petition for admittance into the PhD program only after enrolling in the MS program.

Employment options for PhD graduates are in teaching, research, and extension at universities and in research, consulting or management with private industries and government agencies.

Requirements

- No minimum course requirement. A candidate's committee develops a course plan together with the student.
- 1 credit hour of PEPS 660 each semester, except when enrolled in 799.
- 2 credit hours of 799 Proposal/Defense Seminar (CR/NC).
- Comprehensive and final defense examinations.
- 1 credit hour of 800 Dissertation Research during semester of graduation.
- Submission of acceptable dissertation.

Tropical Plant and Soil Sciences

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Faculty

*R. E. Paull, PhD (Chair)—plant growth and development, postharvest handling
A. S. Arakaki, BS—extension agent, fruit and vegetable production
R. Arce, BS—extension agent, community development, agricultural production
*H. C. Bittenbender, PhD—coffee, kava and tropical fruit physiology and management
*J. L. Brewbaker, PhD—plant breeding, biochemical genetics
*K. T. Cheah, PhD—tissue culture, ornamental horticulture, business management
*J. Deenik, PhD—soil facility, soil management

* Graduate Faculty

*J. DeFrank, PhD—weed science
A. Gachuhi, MS—urban horticulture
J. Grzebik, MS—urban horticulture
*M. Habte, PhD—soil microbiology-biochemistry
*N. V. Hue, PhD—soil chemistry
*A. Kaufman, MLA PhD—landscape specialist
A. F. Kawabata, MS—foliage production and nursery management
*K. D. Kobayashi, PhD—fruit physiology and computer modeling
*K. W. Leonhardt, PhD—ornamental horticulture
T. MacDonald, MS—urban horticulture, extension
*R. M. Manshardt, PhD—tropical fruit breeding and genetics
*S. C. Miyasaka, PhD—alternative crops, plant nutrition
N. M. Nagata, MS—ornamental landscape, turf industries
*T. Radovich, PhD—vegetables, sustainable farming
*A. S. Saulo, PhD—food technology extension, food safety and quality
*P. Singleton, PhD—crop physiology, nutrient management
G. I. Teves, BS—extension agent, ornamentals production
*G. Uehara, PhD—systems simulation in international agriculture
*H. R. Valenzuela, PhD—vegetable management
*A. Wieczorek, PhD—biotechnology
R. M. Yamakawa, MS—extension agent, ornamentals production
*R. S. Yost, PhD—expert systems in soil management, fertility

Cooperating Graduate Faculty

C. I. Evensen, PhD—water quality extension, environmental education
M. K. Kawate, PhD—pesticide registration/weed science
W. S. Sakai, PhD—ultrastructure, physiological plant anatomy
M. J. Tanabe, PhD—in vitro propagation, turf management, plant propagation

Affiliate Graduate Faculty

H. Albert, PhD—plant biotechnology, gene regulation
M. Austin, PhD—agronomy
M. M. M. Fitch, PhD—tissue culture, genetic engineering
M. C. Jackson, PhD—biochemistry, economics
T. Matsumoto, PhD—horticulture
J. J. McHugh, PhD—vegetable management, integrated pest management
R. R. G. Ming, PhD—plant genomics, plant breeding
P. Moore, PhD—plant development, sugar metabolism
C. N. Nagai, PhD—sugar cane genetics and tissue culture
D. Ragone, PhD—ethnobotany, conservation
F. Zee, PhD—plant breeding, genetics

Degrees Offered: BS, MS, and PhD in tropical plant and soil sciences, minor in plant production and management

Program Goals

Upon graduation, students will be able to:

- Integrate discipline- and thematic-specific knowledge of basic and applied plant and soil sciences to its application, analysis, and evaluation in the production, management, and improvement of managed and natural ecosystems.
- Demonstrate an awareness of practices that minimize damage to the environment and ensure a safe food supply.
- Perform competitively in the diverse professions available to them and to take advantage of the opportunities afforded by changing situations.

The Academic Program

The Tropical Plant and Soil Sciences (TPSS) program at UH Mānoa is unique. Students have an opportunity to take courses in tropical flower, fruit, and vegetable crop production, turf and landscape management, plant physiology, breeding and genetics, and soil science. They learn about the full spectrum of subjects and activities required to understand and responsibly manage land, water, crops, and their environments for the benefit of humankind. In addition, they learn about the adaptation and application of new technologies, such as molecular biotechnology, computer-based systems, and the internet, to enhance plant production systems, assure a safe food supply, and protect the environment.

Our students come from many backgrounds including those with little practical environmental or agricultural experience. They have in common a keen interest in applying science for the purpose of finding practical solutions to problems. Mature students are especially welcome. A host of career prospects await our students. The comprehensive undergraduate program affords students the opportunity to study molecules to whole plants to managed agro-ecosystems. Students majoring in TPSS prepare for careers including plant production and management, plant breeding and genetics, services, marketing, extension, research, and teaching. UH Mānoa students trained in tropical plant and soil sciences have embarked on successful careers in international organizations and governmental agencies, in ecological and environmental protection, in agricultural extension as individual entrepreneurs and teachers at all levels, in farming, in golf course/sports field management, park administration, landscape contracting, and as middle and upper management in corporate agriculture. They work in increasing the food supply, improving food quality, and assuring food safety while protecting the environment and improving the quality of life. Undergraduates are encouraged to obtain practical experience, which involves research under the direction of a faculty member and work in a commercial industry via our internship program. Students have found satisfaction in applying their course work and research studies to challenging problems in business, environmental protection, land-use, and agricultural crop production.

Advising

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Students are advised by the department's undergraduate advisor: Dr. Ken Leonhardt. Undergraduate options are detailed in the following section. Each student may identify a faculty member to act as a mentor in the student's area of interest and specialization. All students in TPSS must receive approval of their program of courses from their advisors prior to registration each semester.

Graduate students are advised initially by an advisor or by the department's graduate program chairman.

Undergraduate Study

The program offers a BS degree in tropical plant and soil sciences with specializations in (1) plant physiology and genetics, (2) plant production and management, (3) environmental soil science, and (4) landscape horticulture. A student is required to complete 128 credits to graduate with a BS in TPSS.

Requirements

Students must complete the General Education Requirements (Core) of UH Mānoa. An updated list of the courses recommended to satisfy the UH Mānoa General Education Requirement is available from the undergraduate advisor. The UH's Hawaiian/Second Language graduation requirement can be met by any four-course combination of language, natural science, and social science with a maximum of two social science courses.

The College has a core consisting of the following two courses:

- NREM 310 Statistics in Agriculture and Human Resources
- TPSS 492 Internship

Students must complete the following three courses in the Department:

- TPSS 200 Tropical Crop Science
- TPSS 300 Tropical Production Systems
- TPSS 351 Enterprise Management

Option in Plant Physiology and Genetics

The option crosses the traditional boundaries that have separated genetics, plant physiology, molecular biology, and traditional crop production areas. The option links laboratory approaches and plant production systems through the application of plant biotechnology to solve multi-disciplinary problems. Students can select courses that allow concentration on genetic engineering to address real-world problems or to whole plant physiology and plant breeding.

Students selecting this option must take BIOL 172/172L, 275/275L and 406/406L (or their equivalent), and CHEM 161/161L, 162/162L will fulfill the Natural Science requirement of the UH Mānoa General Education Requirement.

Major (Option) Courses

Take a minimum of 14 credits from the following courses:

- TPSS 440 Tissue Culture/Transformation
- TPSS 450 Nutrient Management of Soils and Plants
- TPSS 453 Plant Breeding and Genetics
- TPSS 470/470L Plant Physiology/Lab
- TPSS 499 Directed Studies
- BIOL/MBBE 402/402L Principles of Biochemistry/Lab or BIOC 441/441L Basic Biochemistry
- BIOL 407 Molecular Biology

For information on a Bachelor Degree Program Sheet, go to www.manoa.hawaii.edu/ovcaa/programsheets/.

Electives (variable number of elective credits)

While students may choose from the array of courses offered at UH Mānoa, an advising list of courses will be available to assist students in selecting courses that prepare students for a career in plant sciences and genetics.

The advising list includes courses in botany, chemistry, biology, physics, geography, business, history, and philosophy. Undergraduate advisors will assist students considering enrollment in graduate school in the selection of appropriate courses.

Option in Plant Production and Management

This option prepares students to produce, manage, and market plants grown as crops or in landscapes. The aim is to enable graduates to perform competitively in their chosen profession and to have a sufficiently broad educational background to take advantage of the opportunities afforded by changing situations.

Students selecting this option need to take BOT 101/101L (or their equivalent) or BIOL 172/172L (or their equivalent) and CHEM 161/161L and 162/162L to fulfill the Natural Science requirement of the UH Mānoa core. These courses are considered prerequisite to upper division courses in the major.

Major Courses (Option in Plant Production and Management)

Take all eight of these courses

- TPSS 200 Tropical Crop Science
- TPSS 300 Tropical Production Systems
- TPSS/NREM 304 Fundamentals of Soil Sciences
- TPSS 351 Enterprise Management
- TPSS 364 Horticultural Practices
- PEPS 363 General Entomology
- PEPS 363L General Entomology Laboratory
- PEPS 405 Plant Pathogens and Diseases

The student must take 6 courses from the following supporting courses for this option:

- TPSS 220 Organic Food Crop Production
- TPSS 322 Marketing Perishable Products
- TPSS 350 Tropical Landscape Practices
- TPSS 369 Ornamental Plant Materials
- TPSS 401 Vegetable Crop Production
- TPSS 402 Flower and Foliage Crop Production
- TPSS 403 Tropical Fruit Production
- TPSS 405 Turfgrass Management
- TPSS 420 Plant Propagation
- TPSS 430 Nursery Management
- TPSS 450 Nutrient Management of Soils and Plants
- TPSS 481 Weed Science
- TPSS 499 Directed Study
- HWST 352 Mahiʻai Kalo II: Advanced Taro

Elective Courses (variable number of elective credits and other courses approved by the undergraduate advisor)

While students may choose from the array of courses offered at UH Mānoa, an advising list of courses will be available to assist students in selecting courses that prepare students for a career in horticultural crop production and management.

The advising list includes courses in botany, chemistry, biology, physics, geography, business, and courses in other departments; PEPS, MBBE, NREM, and HWST. Undergraduate advisors will assist students considering enrollment in graduate school in the selection of appropriate courses.

Option in Environmental Soil Science

The environmental soil science option will prepare students to effectively manage soil for the production of agricultural

commodities and preserve this important natural resource for the benefit of man and the protection of the environment.

Students selecting this option need to take BOT 101/101L (or their equivalent) or BIOL 172/172L (or their equivalent), CHEM 161/161L and 162/162L (or their equivalent), ECON 130, PHYS 151/151L, Business Writing (ENG 209) and Calculus I (MATH 215). Some of these courses will fulfill part of the Natural Science requirement of the UH Mānoa General Education Requirement. These courses are considered prerequisite to some courses in the major.

Major Courses

The following courses need to be taken for this major.

- TPSS/NREM 304 Fundamentals of Soil Science
- TPSS 435 Environmental Soil Chemistry
- TPSS 450 Nutrient Management of Soils and Plants
- NREM 301 Natural Resources Management

Electives

The student must take 12 credits from following electives for this option:

- TPSS 460 Soil Plant Environment
- TPSS 499 Directed Studies
- GEOG 101/101L The Natural Environment
- ICS 101/ 101L Tools for the Information Age
- MET 101 Introduction to Meteorology
- NREM 461 Soil and Water Conservation
- MICR 485 Microbes and Their Environment

For information on a Bachelor Degree Program Sheet, go to www.manoa.hawaii.edu/ovcaa/programsheets/.

Option in Landscape Horticulture

The Department of Tropical Plant and Soil Science's Landscape Horticulture Option prepares students for exciting and diverse careers in the landscape industry. UH Mānoa is centered within the Pacific rim, and is the only U.S. landscape program for sub-tropical and tropical environments, making studying at UH Mānoa a unique experience.

The landscape horticulture option will prepare students to effectively design, install, and maintain landscapes that include trees, shrubs, flowers, house plants, and turf grass that are used to enhance the environment. Students of the program learn theoretical foundations, which lead to a practical understanding and implementation of how to produce environmentally and economically sustainable landscapes.

The landscape industry in Hawai'i is a multi-million dollar business incorporating landscape nurseries, landscape architects, landscape contractors, arborists, and landscape maintenance, and interior landscape companies. Hawai'i has lush resorts, parks, recreation and athletic fields, world-class golf courses, master planned residential communities, and a variety of commercial projects, which offer TPSS students excellent opportunities to choose from upon graduation.

Students selecting this option need to take BOT 101/101L (or their equivalent) or BIOL 172/172L (or their equivalent) and CHEM 161/161L and CHEM 162/162L (or their equivalent) to fulfill the natural science requirement of the UH Mānoa Core. These are considered prerequisite to some upper division courses in the major.

Major Requirements

The following courses need to be taken for this major:

- TPSS 200 Tropical Crop Science
- TPSS 304 Fundamentals of Soil Science (4)
- TPSS 351 Enterprise Management*
- TPSS 463 Irrigation and Water Management
- TPSS 481 Weed Science
- PEPS 363 General Entomology (3) and Lab (1)
- PEPS 405 Plant Pathogens and Disease (4)

Electives

The student must take 7 courses from the following electives for this option:

Group B–Management courses

- TPSS 300 Tropical Crop Production Systems (4)
- TPSS 364 Horticulture Practices (2)
- TPSS 402 Tropical Flower and Foliage Crop Production
- TPSS 405 Turfgrass Management
- TPSS 420 Plant Propagation
- TPSS 430 Nursery Management
- TPSS 435 Environmental Soil Science
- TPSS 450 Nutrient Management of Soils and Plants (4)
- TPSS 460 Soil Plant Environment

Certificate in Agribusiness Management

This certificate fulfills business and management needs for undergraduate students in the technical fields of agriculture and for business/economics students who want to concentrate in agriculture. Faculty from four departments within the college coordinate and manage the program. The certificate is open to undergraduate majors in any CTAHR program, economics and business. NREM 220 or ECON 130 are prerequisites for the program.

The certificate program consists of courses concentrating on the applications of business, management, and economic principles to agribusinesses with particular emphasis on the factors that differentiate agriculture and related products and services from other businesses. The certificate program includes four core agribusiness courses:

Core Courses (12 credits)

- TPSS 322 Marketing Perishable Products or BUS 312 Principles of Marketing
- TPSS 341 Accounting and Financial Analysis
- TPSS 351 Enterprise Management
- TPSS 429 Spreadsheet Modeling for Business and Economic Analysis

Academic Minor in Plant Production and Management

A minimum of 15 credits of non-introductory, upper division level courses must be completed with a grade of C (not C-) or higher for each course. Transfer credits toward the minor will be accepted if an appropriate UH Mānoa course is determined to be equivalent, and if the grade is C (not C-) or higher. Required courses are TPSS 200, 300, and 364. Several optional courses can be selected. See the TPSS academic advisor for details (Dr. Ken Leonhardt, email: leonhard@hawaii.edu).

Graduate Study

Tropical Plant and Soil Sciences

In order to solve the complex problems facing agricultural plant production systems, many disciplines must be integrated successfully. Candidates may specialize in genetics and breeding of tropical fruits, vegetables, or ornamentals; physiology, culture, and management of tropical fruits, vegetables, or ornamentals; morphogenesis; crop and stress physiology; post-harvest physiology; growth regulation; plant biochemical genetics; plant cytogenetics; weed science; computer modeling; or turf and landscape management, cropping systems, plant-soil relationships, soil chemistry, soil physics, soil management, soil and water conservation, soil fertility, and soil microbiology. Courses offered in botany, biochemistry, plant pathology, food science, genetics, microbiology, and zoology, combined with courses offered in TPSS, will provide considerable flexibility in the development of a program suited to a student's career objectives.

The department offers graduate study leading to MS (Plan A, Plan B, and Plan C) and PhD degrees. The TPSS graduate program offers a degree in TPSS and an option in TPSS (horticulture). The degrees emphasize the development of problem-solving skills that integrate molecular, biochemical, physiological, chemical, genetic, and ecological approaches to collaborative research in plant and soil sciences.

The TPSS degree aims to provide the student with a thorough hands-on understanding of the principles and techniques in the adaptation and application of biotechnology to tropical crop plant production, and the role of soils in supporting the whole system of crop production systems. The option requires understanding of fundamental biological processes, molecular and organism biology, genetics, plant physiology, chemistry, physics, and microbiology. Soil is studied both for intrinsic properties, as well as its role in supporting crop growth and as an environmental resource.

The horticulture option explores the many facets of tropical food and ornamental crop production and requires the understanding of agricultural systems, plant production, soil fertility, and protection of the environment, as well as supporting disciplines such as crop ecology, plant physiology, and molecular biology.

The MS and PhD in TPSS are recognized Western Interstate Commission for Higher Education (WICHE) regional graduate programs. Residents of Alaska, Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, Utah, Washington, and Wyoming are eligible, upon admission, to enroll at Hawai'i-resident tuition rates.

Entrance Requirements

For admission to the TPSS graduate programs, applicants must present a bachelor's degree with a GPA of 3.0 (4.0 equals A scale) or the equivalent in the last four semesters or approximately 60 semester credits of the applicant's undergraduate record. The GRE is required for all applicants. A minimum CBT TOEFL score of 173 is required of all foreign students. All applicants must submit 2 letters of recommendation at the time of application.

Transfer of Credits

The transfer of credits to meet the requirements of the MS or PhD is not automatic. The student must petition the graduate program chairman, certifying that the transfers make programmatic sense and that the courses to be transferred are equivalent in rigor and scholastic content to graduate-level (600 level) courses offered at UH Mānoa. The graduate program chairman may consult with the graduate faculty as to the certification. The maximum number of credits that can be transferred is 12.

Only those credits that have not been applied towards the fulfillment of a previous degree may be transferred. An exception may be made if the subject matter area could not be met by course offering at UH Mānoa, provided the courses transferred meet the rigor and programmatic appropriateness criteria described above.

Graduate Committee

Upon entering the graduate program, students will meet with their advisor. If a faculty advisor has not been selected, the graduate chairman or his representative will perform this function. The selection of an advisor must be made before the end of the first semester in residence. The advisor, with the approval of the graduate chairman, shall guide the student on course selection matters, insure progression in the program, and advise the student until the permanent graduate program committee is established.

Students shall meet their permanent graduate program committee at least once each semester to access academic and research progress and to establish goals for the next semester. It is the student's responsibility to schedule this meeting and to file the Academic Progress Report with the graduate chairman.

Master's Degree

Graduates of the Plan A program can further their graduate studies leading to the PhD degree or enter careers as researchers and technicians, while graduates of the Plan B program typically enter careers in education, agribusiness, extension service, and other agriculturally related occupations. The Plan B is regarded as terminal degree in this graduate program. Plan C (examination) option is open to selected students on the recommendation of their graduate program committee. Criteria for selection of Plan C candidates include previous academic records, interviews, levels of performance in the diagnostic examination, and prior research experience.

Requirements

Students will take a written diagnostic examination the week preceding the first day of instruction. The diagnostic examination consists of questions in eight areas including botany, chemistry, biochemistry, mathematics, physics, plant science, statistics, and soil science. The results of this examination will be used by the student's graduate committee, with approval of the graduate program chairman, to select additional courses for the students program.

Plan A students must complete a minimum of 24 credit hours of course work and 6 credit hours of thesis preparation. A final oral examination is required. For Plan B students must complete a minimum of 30 credit hours, including a minimum

of 18 credit hours earned in courses numbered 600 to 798 of which a majority must be in TPSS. A maximum of 6 credit hours (Plan B) or 2 credit hours (Plan A) in 699 may be credited towards the 30 credit hours applied.

All students must take 654 as soon as possible after beginning their studies and register for seminar (667) once every academic year in which they are registered as full-time or equivalent, except the final semester, in which the dissertation defense or Plan B project report is given, can be substituted for seminar.

Doctoral Degree

Graduates of the PhD program have entered careers as researchers and/or educators in institutions of higher learning and in public and private institutions.

The PhD is awarded only for original scholarly achievement. The dissertation, which is a significant original contribution to basic knowledge in the candidate's field, is required. Only students with above average academic records in pre-doctoral programs will be accepted in the program.

Requirements

Students will take a written diagnostic examination the week preceding the first day of instruction of their first semester as a TPSS graduate candidate. The diagnostic examination consists of questions in eight areas including botany, chemistry, biochemistry, mathematics, physics, plant science, statistics, and soil science. The results of this examination will be used by the student's graduate committee, with approval of the graduate program chairman, to select additional courses for the student's program.

Course requirements are established by the student's graduate committee. Following a preliminary conference with the program advisor and/or committee, and with the approval of the graduate program chairman, the student will be officially advanced to candidacy. After admission to candidacy and the completion of most courses in the candidate's program, the candidate must take oral comprehensive examinations covering all subjects considered relevant to the concentration. A seminar on the proposed research topic may be also required by the student's permanent committee. A final oral examination, which includes a public defense of the dissertation, is required of all candidates.

For all PhD students, a minimum of 12 credit hours in courses numbered 400 or above is required for the major, not including seminar, directed research, thesis/dissertation research. Candidates must register for seminar (667) once every academic year in which they are registered as full-time or equivalent, except the final semester, in which the dissertation defense can be substituted for seminar. PhD candidates who have not had 654 Communications in the Sciences or its equivalent must take this course during their first year as a substitute for one semester of 667.

Courses Available for Each Option

Tropical Plant and Soil Sciences

- TPSS 500 Master's Plan B/C Studies
- TPSS 601 Crop Modeling
- TPSS 603 Experimental Design
- TPSS 604 Advanced Soil Microbiology
- TPSS 610 Nutrition of Tropical Crops
- TPSS 614 Molecular Genetics of Crops
- TPSS 615 Quantitative Genetics
- TPSS 640 Advanced Soil Chemistry
- TPSS 650 Soil Plant Nutrient Relations
- TPSS 652 Information Research Skills
- TPSS 654 Communications in the Sciences
- TPSS 664 Orchidology
- TPSS 667 Graduate Seminar
- TPSS 670 Agrarian Systems Analysis
- TPSS 674 Plant Growth and Development
- TPSS 680 Geospatial Analysis of Natural Resource Data
- TPSS 695 Plan B Master's Project
- TPSS 699 Directed Research
- TPSS 700 Thesis Research
- TPSS 711 Special Topics
- TPSS 800 Dissertation Research
- MBBE 620 Plant Biochemistry
- MBBE 680 Methods in Plant Molecular Biology

Tropical Plant and Soil Sciences - Horticulture

- TPSS 500 Master's Plan B/C Studies
- TPSS 601 Crop Modeling
- TPSS 603 Experimental Design
- TPSS 604 Advanced Soil Microbiology
- TPSS 610 Nutrition of Tropical Crops
- TPSS 614 Molecular Genetics of Crops
- TPSS 615 Quantitative Genetics
- TPSS 640 Advanced Soil Chemistry
- TPSS 650 Soil Plant Nutrient Relations
- TPSS 654 Communications in the Sciences
- TPSS 664 Orchidology
- TPSS 667 Graduate Seminar
- TPSS 670 Agrarian Systems Analysis
- TPSS 674 Plant Growth and Development
- TPSS 680 Geospatial Analysis of Natural Resource Data
- TPSS 695 Plan B Master's Project
- TPSS 699 Directed Research
- TPSS 700 Thesis Research
- TPSS 711 Special Topics
- TPSS 800 Dissertation Research