



# 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](http://www.ctahr.hawaii.edu)

Dean and Director: Nicholas Comerford  
Interim Associate Dean: Ania Wiecek  
Interim Associate Dean: Jinzeng Yang  
Interim Associate Dean: Kelvin T. Sewake

## 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, fashion 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 dietetics, BS in fashion design and merchandising, BS in biological engineering, BS in food science and human nutrition, BS in human development and family studies, BS in molecular biosciences and biotechnology, BS in natural resources and environmental management, BS in tropical agriculture and the environment

## Contents

General Information.....	336
Advising.....	337
Undergraduate Programs.....	337
Graduate Programs.....	337
Instructional and Research Facilities.....	338
Student Organizations.....	338
Honors and Awards.....	338
Family and Consumer Sciences.....	339
Fashion Design & Merchandising Program.....	340
Human Development and Family Studies.....	340
Human Nutrition, Food and Animal Sciences.....	342
Molecular Biosciences and Bioengineering.....	350
Molecular Biosciences and Biotechnology Program.....	354
Natural Resources and Environmental Management.....	355
Plant and Environmental Protection Sciences.....	360
Tropical Plant and Soil Sciences.....	365



**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 Hall First Floor  
3050 Maile Way  
Honolulu, HI 96822  
Tel: (808) 956-8183 or (808) 956-6733  
Fax: (808) 956-3706  
Email: [ctahradv@hawaii.edu](mailto:ctahradv@hawaii.edu)  
Web: [www.ctahr.hawaii.edu/ugadvising](http://www.ctahr.hawaii.edu/ugadvising)

Academic advisors are available by appointment only  
Monday-Friday from 8:30 a.m.-3:30 p.m. (except on holidays).  
Appointment website: [ctahradv.youcanbook.me](http://ctahradv.youcanbook.me)

## 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, and natural resources and environmental management majors. Transfer students are required to have a minimum GPA of 2.5 for natural resources and environmental management majors, and 3.0 for food science and human nutrition majors. Pre-requisite course work is also required

for food science and human nutrition majors. 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 45 credit hours of upper division courses (300+ level courses), earn a minimum cumulative 2.0 GPA in major courses, and maintain a minimum cumulative GPA of 2.0 in a minimum of 120 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: HDFS 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 a CTAHR academic advisor for more information.

## Multiple Majors/Degree

Students seeking a multiple major/degree must have a minimum 3.0 cumulative GPA, submit an application, personal statement and academic plan, in addition to meeting with a CTAHR academic advisor. Students desiring to add a CTAHR major/degree as their secondary major/degree, must successfully complete the introductory course for the CTAHR major with a C or better (except for FSHN, which must be completed with a B or better) and started math, chemistry, and biology course work if required for the proposed major.

## Second Degree

Students may enter CTAHR as a second degree student. Requirements for admission are the same as those for the UH Mānoa campus in general, except for food science and human nutrition (FSHN), and natural resources and environmental management (NREM) majors. Second degree students are required to have a minimum GPA of 2.5 for NREM and 3.0 for FSHN majors. Pre-requisite course work is also required for FSHN majors. Students seeking a second degree must 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.

## Graduate Programs

Graduate studies leading to a master of science degree are available in nine fields: animal sciences; biological engineering; entomology; food science; molecular biosciences and bioengineering; 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 State of Hawai'i Department of Agriculture.

Students may contact individual departments, 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 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 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 Horticulture Society
- Friends of the Family
- CTAHR Student Ambassadors
- Natural Resources and Environmental Management Graduate Student Organization
- Ka Mea Kolo (Entomology Club)
- SOFT: Student Organic Farm Training
- Tropical Plant Pathology Graduate Student Organization
- Biological Engineering Student Association
- Tropical Plant and Soil Sciences Graduate Student Organization

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

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

Human Development and Family Studies  
Krauss Annex 7  
Tel: (808) 956-6519

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

## Faculty

- B. W. K. Yee, PhD (Chair)—Asia and Pacific Islander adult development and aging, women's health, Southeast Asians, minority career paths
- Y. Bahng, PhD—retailing, international merchandising, and entrepreneurship (FDM)
- M. Berry, PhD—policies, practices, and programs in child and family welfare, including family support, abuse prevention, foster care and adoption (COF)
- R. A. Caulfield, PhD—infancy, childhood, life span development (HDFS)
- M. Cheang, DrPH—family resource management, family caregiving (HDFS)
- J. L. Chong, MEd—adult and youth volunteer and leadership development, 4-H youth development (Hawai'i Cooperative Extension Service)
- M. A. Cristi, MS—merchandising management; consumer behavior and sociology (FDM)
- B. De Baryshe, PhD—child development, early childhood education, family resilience (COF)
- J. Goodwin, PhD—volunteer development, leadership development, ethical decision-making education, 4-H program management (Cooperative Extension Service)
- H. Greenwood-Junkemeier, MS—aging and intergenerational programs (Maui Cooperative Extension Service)
- J. Kang, PhD—consumer behavior in digital commerce; apparel product development and retail store design using 2D/3D CAD (FDM)
- L. J. Kawamura, MPH—4-H youth development, foods and nutrition (Kaua'i Cooperative Extension Service)
- T. N. Le, PhD, MPH—risk and resilience of Asian and Indigenous youth; mindfulness-based interventions (HDFS)
- S. Lewin-Bizan, PhD—parenting and father-child relationships; child and youth development within the contexts of family, school, and economic resources; fatherhood program evaluation (HDFS)
- S. Lin, PhD—textile/costume conservation, product lifecycle management (FDM)
- M. I. Martini, PhD—parenting and family relationships across cultures (HDFS)
- D. M. Masuo, PhD—consumer and family economics (HDFS)
- C. M. Nakatsuka, MEd—4-H youth division-military 4-H partnerships (O'ahu Cooperative Extension Service)
- N. E. Ooki, MA—youth development, 4-H (Maui Cooperative Extension Service)
- A. H. Reilly, PhD—social psychology of appearance including body image (FDM)
- R. L. Settlage, MS—4-H youth development livestock (Hawai'i Cooperative Extension Service)
- J. J. Yahirun, PhD—aging, health, intergenerational relationships, life course, migration/immigration (COF)

- L. A. Yancura, PhD—stress and aging, research methodology, grandparents raising grandchildren, family caregivers (HDFS)
- H. Zan, PhD—economics of health behaviors, health and healthcare, caregiving and intergenerational transfer, household consumption (COF)

**Degrees Offered:** BS in fashion design and merchandising, minor in merchandising, BS in human development and family studies, 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: Fashion Design and Merchandising (FDM) and Human Development and Family Studies (HDFS).

The FDM 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.

HDFS is a Bachelor of Science degree program that provides students with a comprehensive, ecological systems-based program of study in life span development and family resource management. The HDFS curriculum emphasizes the study of child, adolescent, 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, life span development, family life education, family and consumer sciences, and marriage and family therapy.

With supplementary course work, students may pursue graduate training in other social science disciplines such as social work, educational counseling, public health, urban and regional planning (e.g., community development), sociology, psychology, and law.

In addition to courses offered in the department, there are 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 HDFS majors while *Innovators of Fashion (IF)* does the same for FDM majors. Majors from any discipline are welcome to join FOF and IF.

## Undergraduate Study

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 FDM and HDFS degree candidates must fulfill one of the following Quantitative Reasoning courses: BUS 250, ICS 141, ICS 241, MATH 100, 112, 140\*, 161, 203\*, 215\*, 241\*, 251A\*, NREM 203, PHIL 110, 110A, or 111. (Please note that MATH 103, 104, and 135 do not fulfill the quantitative reasoning requirement for FDM and HDFS.)

\* Math Department's Precalculus Assessment required.

### Academic Advising

For academic advising, see the contact information in the front section. Academic advisors are available by appointment only, Monday-Friday from 8:30 a.m.-3:30 p.m. (except holidays). Appointment website: [ctahradv.youcanbook.me](http://ctahradv.youcanbook.me). Gilmore Hall, first floor, email: [ctahradv@hawaii.edu](mailto:ctahradv@hawaii.edu). Advising website: [www.ctahr.hawaii.edu/ugadvising](http://www.ctahr.hawaii.edu/ugadvising).

### Career Advising

Fashion Design and Merchandising  
Miller 201

2515 Campus Road  
Honolulu, HI 96822  
Tel: (808) 956-8133

Email: [fcs@ctahr.hawaii.edu](mailto:fcs@ctahr.hawaii.edu)

Human Development and Family Studies

Krauss Annex 7  
2515 Campus Road  
Honolulu, HI 96822  
Tel: (808) 956-6519

Email: [fcs@ctahr.hawaii.edu](mailto:fcs@ctahr.hawaii.edu)

### Fashion Design and Merchandising Program

Fashion Design and Merchandising (FDM) 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 one of the largest costume collections at a university in the U.S., giving students and faculty a rich source of items to draw upon for their classes and projects. In addition, students have the opportunity to use web-based technologies to supplement classroom activities. 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 FDM 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 FDM core includes required courses in the fashion industry, textiles, fashion forecasting, historic costume, the social psychology of dress, and apparel construction. The core prepares students for career positions in both creative

and business management areas of local and global fashion industries. Upon completing the core requirements, students take classes in 3 of 4 tracks: Design, Merchandising, Cultural, and Textile and Apparel topics.

### 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 2.0 to be considered for admission to FDM.

### Minor

The merchandising minor gives students who are not FDM 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. Minimum GPA of 2.0 needed to be considered.

### 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 FDM majors 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 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;
3. 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;
4. 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;
5. The ability to identify, locate, analyze, and synthesize relevant information and to effectively communicate ideas in written, oral, and visual forms using appropriate technologies;
6. 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/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

### Human Development and Family Studies

The Human Development and Family Studies (HDFS) (formerly 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. HDFS courses provide students with knowledge that they can apply to their personal development and family life. An internship in the student's area of interest 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/schools within the UH System or from other universities must have a minimum GPA of 2.0 to be considered for admission to HDFS.

### 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 HDFS 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/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

## Additional Opportunities

### Provisional Certified Family Life Educator

The National Council on Family Relations (NCFR) has approved the human development and family studies 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. HDFS 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. HDFS 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: cms.ctahr.hawaii.edu/hnfas2/Academics.aspx

## Faculty

- \*J. Yang, PhD (Chair)—molecular biology and animal biotechnology
- \*J. Banna, PhD, RD, CDN (Graduate Chair, Nutritional Sciences MS PhD Nutrition program)—community nutrition, nutrition education in minority populations
- \*R. Jha, PhD (Graduate Chair, Animal Sciences MS)—feed evaluation and animal nutrition
- \*Y. Li, PhD (Graduate Chair, Food Science MS program)—food microbiology, food safety and probiotics
- \*B. A. Buckley, PhD—beef production and breeding
- \*K. C. Caires, PhD—reproductive physiology, quantitative and molecular genetics, genetic improvement of livestock, sustainable livestock production and management practices
- A. Ditzler, RD—dietetics, ISPP Coordinator
- \*J. Dobbs, PhD—food composition, nutrition, domestic animals, avian and wildlife nutrition
- \*M. W. DuPonte, MS—livestock extension education (Hawai'i Cooperative Extension Service)
- \*M. K. Esquivel, PhD, RDN—nutrition and lifestyle behavior-related health disparities in the Pacific
- \*M. K. Fialkowski Revilla, PhD, RD, LD—indigenous nutrition, nutrition education, community nutrition
- \*G. K. Fukumoto, MS—livestock extension education (Hawai'i Cooperative Extension Service)
- \*C. Y. Hu, PhD—animal growth, adipose differentiation, lipid metabolism
- \*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
- \*B. Mishra, DVM, MS, PhD—reproductive physiology, environmental stress on reproductive outcomes
- \*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 (Interim Dean)—community and global nutrition, nutritional epidemiology
- \*J. S. Odani, DVM, DACVP, Co-Pre-veterinary medicine Program Advisor—veterinary anatomy and diagnostic pathology
- \*A. P. Seale, PhD—fish endocrinology, environmental 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
- \*D. L. Vincent, PhD, PAS, Co-Pre-veterinary medicine Program Advisor—reproductive physiology and endocrinology
- \*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

A. Garcia-Ortega, PhD

P. Lenz, PhD—neuroecology of zooplankton sensory systems

B. W. Mathews, PhD—aquaculture and nutrition

## Affiliate Graduate Faculty in Animal Sciences

J. Carpenter, PhD—livestock and marine mammal nutrition

## Cooperating Graduate Faculty in Food Sciences

J. Bingham, PhD—biochemistry, peptide synthesis

D. Borthakur, PhD—microbiology, biotechnology

L. Gautz, PhD—instrumental quality evaluation

Q. X. Li, PhD—bioremediation, environmental biotechnology

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

## Cooperating Graduate Faculty in Nutritional Sciences

M. J. Berry, PhD—selenoproteins, antioxidants and human diseases

C. J. Boushey, PhD—nutritional epidemiology, obesity and cancer

H. Davis, PhD—mitochondria

A. Franke, PhD—analytical chemistry, phytochemicals

R. Hertzler, 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

P. V. Nerurkar, PhD—medical biochemistry

C. R. Nigg, PhD—exercise behavior

## Affiliate Graduate Faculty in Nutritional Sciences

R. Leon-Guerrero, PhD—obesity and chronic disease prevention, diet assessment

## 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

C. J. Boushey, PhD—nutritional epidemiology, obesity and cancer

R. Cooney, PhD—tocopherols, carotenoids and coenzyme Q-10 mechanisms of action in health and disease

A. Franke, PhD—analytical chemistry, lab assessments, phytochemicals

A. Grandinetti, PhD—epidemiology of diabetes and metabolic syndrome

R. Hertzler, PhD—exercise physiology, sports nutrition

J. D. Latner, PhD—clinical psychology, eating behaviors and disorders, obesity

L. LeMarchand, MD, MPH, PhD—nutritional epidemiology, genetic markers

G. Maskarinec, MD, MPH, PhD—nutritional epidemiology, soy, hormones and cancer

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

M. Okihiro, PhD—childhood obesity, early metabolic risk in Hawai'i

L. Wilkens, DrPH—biostatistics

**Degrees Offered:** BS in animal sciences, BS in Dietetics, 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. Three BS degrees are available: animal sciences (ANSC), dietetics, food science and human nutrition (FSHN). The pre-veterinary

medicine program is located in the department to provide advising for students seeking to attend veterinary professional training after college. Three MS degrees are offered: animal sciences, nutritional sciences, and food science. The department is also the home 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 and goats, 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 dietetics or in food science and human nutrition (FSHN) have a strong science base that is applied to food and human nutrition. Degree options in FSHN include: Pre-professional Nutrition, Sports and Wellness Nutrition, Pre-professional Food Science, Business Food Science, and Culinology. The Dietetics degree is accredited by the Accreditation Council for Education in Nutrition and Dietetics and fulfill the academic requirements for becoming a Registered Dietitian Nutritionist. 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 FSHN curriculum options or dietetics are prepared for diverse careers in the food industry, healthcare 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 these related disciplines.

Culinology® combines the education and training in Culinary Arts and Food Science with experiential learning in food service and food production industries. This program option offers students the opportunity to apply and practice skills learned in all aspects of the Culinary Arts in a real world environment.

This program has been accredited by the Research Chefs Association (RCA) as one of the 15 Culinology® programs in

the U.S. The new professional who epitomizes this discipline will be someone who combines the passion, skill, and creative talent to prepare and present innovative new food products, together with the scientific and technical knowledge required to provide safe, affordable, healthy, and delicious food products commercially. A Culinology® program prepares students for careers in food processing, product development, foodservice equipment manufacturing, or consulting.

Upon entering animal sciences (ANSC), dietetics (DTCS), 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, DTCS, and ANSC majors are required to report for advising prior to registration each semester. Please contact the CTAHR Academic Advising Office.

## Undergraduate Study

### BS in Animal Sciences/Pre-Veterinary Medicine

#### Degree Requirements

- Course work in the basic sciences, mathematics, economics, and animal sciences including the following:
  - MATH 140 or 203, 215, 241, NREM 203, BUS 250
  - PHYS 151/151L
  - CHEM 161/161L, 162/162L, and 272/272L
  - NREM 220 or ECON 131
  - MBBE 402/402L
  - BIOL 171/171L
- Animal sciences required courses:
  - ANSC 200, 201, 244, 301, 301L, 321, 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, or 450
- Additional electives to make a total of 120 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/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

#### Pre-Veterinary Medicine

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 Medicine Program. A BS degree in a science-related field is desirable but not required for veterinary schools. The CTAHR Pre-Veterinary Program advisor assists students in meeting the admission requirements of veterinary



schools, including academic requirements and veterinary/animal experience requirements. The Pre-Veterinary Medicine Program offers opportunities to gain experience through mentorship with local veterinarians and those in the various animal industries of Hawai'i. The department also sponsors the Pre-Veterinary Medicine Club of Hawai'i, which offers students opportunities to interact with other students interested in veterinary medicine as well as participate in hands-on activities and other club events. Hawai'i residents are eligible to apply for participation in the Western Interstate Commission for Higher Education (WICHE) program that includes agreements with Colorado State University, Washington State University, Oregon State University, and the University of California at Davis to preferentially accept students from the Western Region as a subset of each entering veterinary class. 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/](http://www.aavmc.org/) and for more information about specific requirements for admission to veterinary schools. Students seeking additional information and advising should contact the Pre-Veterinary Medicine Program [prevetprogram@ctahr.hawaii.edu](mailto:prevetprogram@ctahr.hawaii.edu), advisor Dr. Jenee Odani, [jsodani@hawaii.edu](mailto:jsodani@hawaii.edu), or the Department of Human Nutrition, Food, and Animal Sciences, Agricultural Sciences Building, 1955 East-West Road, Room 216, Honolulu, HI 96822 (808) 956-3847.

## **BS in Dietetics**

### **Admissions**

Students choosing a professional career as a registered dietitian nutritionist (RDN) and who desire to do nutrition counseling should apply to the BS in Dietetics. Students are admitted as juniors or as transfer students (from FSHN, other majors, other institutions) if they have met the following admission requirements: minimum cumulative GPA 3.0, C or higher in CHEM 161/161L, CHEM 162/162L, PHYL 141/141L, PHYL 142/142L, and MATH 140 or higher, B or higher in FSHN 185, and completion of 60 credits of college course work.

The Didactic Program in Dietetics at UH Mānoa is currently granted accreditation by the Accreditation Council for Education in Nutrition and Dietetics (ACEND), 120 South Riverside Plaza, Suite 2000, Chicago, IL 60606-6995, (800) 877-1600, ext. 5400. Students who have successfully completed the BS in dietetics program will be issued a DPD verification statement declaring eligibility for acceptance into an accredited dietetic internship. Students must be accepted and complete an accredited dietetic internship or supervised practice program in order to be eligible to take the national dietetic registration examination administered by the Commission on Dietetic Registration. Students should note that in 2024, the Commission on Dietetic Registration will require that individuals wishing to take the national dietetic registration examination also hold a graduate degree (masters or higher) to be eligible. The average GPA of students admitted to internship programs is 3.3. Students may contact Dr. Monica Esquivel ([monicake@hawaii.edu](mailto:monicake@hawaii.edu)), the Dietetics Program Director, and are encouraged to refer to the Dietetics Student Handbook for more information about this option ([cms.ctahr.hawaii.edu/LinkClick.aspx?fileticket=c-yO4bLB\\_5E%3d&portalid=161](https://cms.ctahr.hawaii.edu/LinkClick.aspx?fileticket=c-yO4bLB_5E%3d&portalid=161)).

Work and/or volunteer experience in the field of interest is highly recommended. Courses required for the BS in Dietetics include BIOL 340 or CMB 411, PHRM 201, SOC 100, PSY 100, FSHN 311, 312, 322, 381, 381L, 451, 467, 468, 469, 480, and 488.

## **BS in Food Science and Human Nutrition**

### **Admissions**

Incoming freshmen are admitted directly to the major. Transfer student from other majors and transfer students from other institutions with interest in the Food Science and Human Nutrition (FSHN) major must meet UH Mānoa general admission criteria prior to being accepted into the FSHN major. Students wishing to enter the FSHN-Culinology® option must complete course work at Kapiolani Community College (KCC). The curriculum is a career-pathway structure that begins with a Culinary Arts (CULN) with a concentration in Institutional Food Service Management AS degree at a community college and culminates in a BS degree in Food Science and Human Nutrition with a Culinology® track. Students master the basic skills and knowledge in Culinary Arts, then the Food Science knowledge and skills are learned at UH Mānoa. KCC offers an associate degree in Culinary Arts with a concentration in Institutional Food Service Management, 4303 Diamond Head Road, Honolulu, HI 96816, [culinary.kapiolani.hawaii.edu](mailto:culinary.kapiolani.hawaii.edu), (808)-734-9499.

While at KCC, students are encouraged to select courses applicable to UH Mānoa General Education, major requirements and prerequisites. Students considering matriculating to UH Mānoa should seek academic advising from advisors on either campus.

### **Degree Requirements—All Human Nutrition Options**

Course work in the basic sciences and mathematics for all human nutrition options include the following: MATH 140 or above, NREM 203, CHEM 161/161L, 162/162L, 272, PHYL 141/141L, 142/142L, MBBE 375, 402, BIOC 341, or 441, BIOL 171/171L, NREM 310. COMG 151 or 251 is also required.

Course work within the major include the following: FSHN 181/181L, 185, 370, 389, 485, 486, 492. To fulfill degree requirements, students must also complete the coursework designated in one of the options listed below.

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

### **BS in Dietetics**

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. The Didactic Program in Dietetics at UH Mānoa is currently granted accreditation by the Accreditation Council for Education in Nutrition and Dietetics (ACEND), 120 South Riverside Plaza, Suite 2000, Chicago, IL 60606-6995, (800) 877-1600 ext. 5400. 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 3.2 or above to be competitive for

internship programs. Students may contact Dr. Monica Esquivel (808) 956-8691, ([monicake@hawaii.edu](mailto:monicake@hawaii.edu)), the Dietetics Program Director, and are encouraged to refer to the Dietetics Option Student Handbook for more information about this option ([cms.ctahr.hawaii.edu/hnfas2/Academics/Dietetics.aspx](http://cms.ctahr.hawaii.edu/hnfas2/Academics/Dietetics.aspx)). Work and/or volunteer experience in the field of interest is highly recommended. Courses required for the Dietetics Option include BIOL 340 or CMB 411, PHRM 203, SOC 100, PSY 100, FSHN 311, 312, 322, 381, 381L, 440, 451, 467, 468, 469, 480, and 488.

For information on a Bachelor Degree Program Sheet, go to [www.manoa.hawaii.edu/ovcaa/programsheets/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

### Human Nutrition 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 Academy of Nutrition and Dietetics to apply for a dietetic internship. Students in the Pre-professional option must take the following: a minimum of 9 credits of FSHN courses numbered 200 or higher; and MICR 130/140L or FSHN 440; and courses in BIOL 275, 340, 375, and CMB 411; and 17 credits of electives.

For information on a Bachelor Degree Program Sheet, go to [www.manoa.hawaii.edu/ovcaa/programsheets/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

### Human Nutrition Sports and Wellness Option

Students who are interested in pursuing a career in sports and wellness, are required to complete course work in Structural kinesiology, Exercise Physiology, and Nutrition in Exercise and Sport (FSHN 480). Students in the Sports and Wellness option must take the following: a minimum of 9 credits of FSHN courses numbered 200 or higher; and MICR 130/140L or FSHN 440; and KRS 353, 354/354L, FSHN 480, and 8 credits of approved electives.

For information on a Bachelor Degree Program Sheet, go to [www.manoa.hawaii.edu/ovcaa/programsheets/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

### Degree Requirements–Food Science Options

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.

Course work in the basic sciences and mathematics for all food science options include the following: MATH 140 or above, CHEM 161/161L, 162/162L, 272, PHYL 151, MICR 130, 140L, MBBE 375 or 402, BIOL 171/171L, NREM 310. COMG 151, or 251 is also required.

Students in the Food Science option must take the following FSHN courses: FSHN 181/181L, 185, 381, 381L, 403, 411, 430/430L, 440, 445, 460, 477/477L, 494. All FSHN majors selecting the Food Science Option must select one of the following specialties to complete degree requirements:

- Business: ACC 201, BUS 312, 315, ECON 130, IS 250
- Pre-professional: CHEM 272L/273, MATH 215, 216, PHYS 152.
- Culinary: AS degree in Culinary Arts from KCC is required. Students need to obtain advisor approval by contacting Lori Maehara at [lmaehara@hawaii.edu](mailto:lmaehara@hawaii.edu) prior to entering the culinology program.

For information on a Bachelor Degree Program Sheet, go to [www.manoa.hawaii.edu/ovcaa/programsheets/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

### Requirements

A total of at least 120 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](mailto: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](mailto: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, and zoology. Because of the diversity of specializations within animal sciences, specific course requirements will vary considerably among students. Further information is available at [cms.ctahr.hawaii.edu/hnfas2/academics/animalsciences\(ms\).aspx](https://cms.ctahr.hawaii.edu/hnfas2/academics/animalsciences(ms).aspx).

## 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. The program does not include an RD internship. Cooperating programs include public health, kinesiology and rehabilitation science, food science, animal sciences, physiology, John A. Burns School of Medicine, and the University of Hawai'i Cancer Center.

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.

## 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 course work at the graduate level, 12 of which must be at the 600 level (excluding 699 and 700);
- 2 credits of 699; and
- 10 credits of 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)
- 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, 685 or 784, 689, a graduate-level statistics course, and at least one of the following: FSHN 682, 686, 784, 785, PH 684 or 688. FSHN 681 Seminar in Food and Nutritional Sciences, must be taken at least four times, including at least twice for a letter grade (A-F). 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 [cms.ctahr.hawaii.edu/hnfas2/academics/nutritionalsciences\(ms\).aspx](http://cms.ctahr.hawaii.edu/hnfas2/academics/nutritionalsciences(ms).aspx).

### Financial Aid

CTAHR has scholarships available to qualified students. Graduate students are able to apply for the Alexander Napier, Hiroki Kaku, and Sachi-yuki Masumoto scholarships. More information may be found at [www.ctahr.hawaii.edu/site/Scholarships.aspx](http://www.ctahr.hawaii.edu/site/Scholarships.aspx).

In addition, STAR Giving Tree scholarship funds may be available to qualified admitted applicants. Information regarding applying for these funds is sent out each year by the graduate committee.

### 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);
- 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 [cms.ctahr.hawaii.edu/hnfas2/academics/foodscience\(ms\).aspx](http://cms.ctahr.hawaii.edu/hnfas2/academics/foodscience(ms).aspx).

### 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.); and
4. Ability to conduct original scholarly research, develop skills in research methodologies and grant writing, understand research ethics, and effectively disseminate 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), John A. Burns School of Medicine (JABSOM), and 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 these 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. The resume and personal statement of applicants should be sent electronically to the graduate chair PhD in Nutrition at [hfnas@ctahr.hawaii.edu](mailto:hfnas@ctahr.hawaii.edu).

### Degree Requirements

The principal requirements for the PhD degree are:

1. Pass a qualifying examination,
2. Complete required course work,
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 failing the exam twice must withdraw from the program. 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. 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. The proposal should consist of a written and oral presentation of the proposed dissertation research. 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 committee will consist of the student's advisor and at least four 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 course work (excluding research credits) beyond their MS degree. If entering with a BS degree, at least 36 credits of graduate level course work (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 course work:

- 11 credits of required nutrition courses [FSHN 601, 685, 689 and at least one of the following: FSHN 668, 682, 784, or 785], including 2 credits of FSHN 681;
- 3 credits in statistics at the graduate level (e.g. PH 655); and
- 4 credits of advisor-approved electives

In addition, at least 12 credits of 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 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: [cms.ctahr.hawaii.edu/hnfas2/academics/nutrition\(PhD\).aspx](http://cms.ctahr.hawaii.edu/hnfas2/academics/nutrition(PhD).aspx).

**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 course work 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 Graduate Division's standards for all Mānoa doctorate programs. A student must pass this exam to achieve candidacy and 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 Graduate Division's standards for all UH Mānoa doctorate programs. Further information is available at: [cms.ctahr.hawaii.edu/hnfas2/academics/Nutrition\(PhD\).aspx](http://cms.ctahr.hawaii.edu/hnfas2/academics/Nutrition(PhD).aspx).



## 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  
1955 East-West Road  
Honolulu, HI 96822  
Tel: (808) 956-8384  
Fax: (808) 956-3542  
Email: mbbe@ctahr.hawaii.edu  
Web: www.ctahr.hawaii.edu/mbbe/

### Faculty

- \*D. Christopher, PhD (Chair)—photosynthesis, plant biotechnology, gene regulation, genomics, protein folding
- \*J. P. Bingham, PhD (Graduate Chair)—peptide synthesis, marine neurotoxins
- \*D. Borthakur, PhD—plant-microbe interaction, plant biotechnology
- \*L. D. Gautz, PhD—bioproduction control and automation, electromechanical systems engineering
- \*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
- \*C. Kinoshita, PhD—heat and mass transport in chemically reacting systems, energy conversion, bioremediation
- \*R. Kurasaki, MS, PE—dynamic systems modeling
- \*Q. Li, PhD—bioremediation, environmental biotechnology
- \*P. Nerurkar, PhD—carcinogen-induced metabolic disorders and biochemical mechanisms of environmental carcinogenesis
- \*D. Owens, PhD—plant biochemistry, enzymology, plant natural products
- \*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 at the rank of assistant professor or higher are regular graduate faculty in Molecular Biosciences and Bioengineering.

### Cooperating Graduate Faculty

- R. Allsopp, PhD—stem cells, regulation of telomerase expressor in cells
- A. S. Bachmann, PhD—tumor growth and cell differentiation
- F. R. Bellinger, PhD—selenoproteins in brain function
- M. J. Berry, PhD—selenoproteins, antioxidants, and human diseases
- W. A. Biosvert, PhD—cardiovascular research
- S. Callahan, PhD—genetics, cellular differentiation, and coral microbiology
- S. Cao, PhD—natural products therapeutics
- M. Carbone, MD, PhD—cancer biology
- S. Chang, PhD—vaccine development, molecular immunology
- M. Cooney, PhD—marine biotechnology
- H. G. de Couet, PhD—molecular biology, invertebrate biology, biotechnology
- T. Ernst, PhD—magnetic resonance imaging
- C-E. Ha, PhD—biochemistry, human serum albumin
- T. Hoang, PhD—molecular microbiology
- J. Hu, PhD—plant virology
- R. Jha, PhD—animal nutrition, feed evaluation, carbohydrate

- metabolism, gut physiology and health
- S. Jun, PhD—food engineering
- Y. S. Kim, PhD—animal biotechnology
- S. Lozanoff, PhD—renal and craniofacial morphogenesis
- Y. Lu, PhD—environmental health
- S. M. Masutani, PhD—thermal conversion of biomass
- A. Maunakea, PhD—biomedical science, epigenomics
- S. Moisyadi, PhD—mammalian transgenesis
- C. Morden, PhD—molecular systematics
- L. Ndhlovu, PhD—HIV immunology
- V. Nerurkar, PhD—molecular virology and epidemiology
- H. L. Ng, PhD—protein structure
- J. Ramos, PhD—cancer biology
- R. Shohet, MD—molecular medicine
- S. Sung, PhD—bioremediation
- S. Q. Turn, PhD—biomass gasification
- C. Walton, PhD—cardiovascular research
- J. Yang, PhD—molecular biology and animal biotechnology
- J. Yu, PhD—bioengineering, marine bioproduct development

### Affiliate Graduate Faculty

- J. Zhu, PhD—plant transformation, biotechnology

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

## The Academic Programs

The Department of Molecular Biosciences and Bioengineering (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 molecular biosciences and biotechnology (BS).

## Biological Engineering Program

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. A strong emphasis throughout the program is placed on a systems approach to problem solving.

## Undergraduate Study

### BS in Biological Engineering

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 two educational objectives, which describe what graduates are expected to attain within a few years after graduation.

1. Graduates will practice engineering in professional careers that serve the needs of society in fields such as biotechnology, environmental systems, energy, or agriculture.
2. Graduates will contribute to their communities by continuing to engage in professional development, ethical decision making, and thoughtful discourse on contemporary issues.

Students are expected to demonstrate accomplishment of the following outcomes at the time of graduation:

- a. An ability to apply knowledge of mathematics, science, and engineering.
- b. An ability to design and conduct experiments, as well as to analyze and interpret data.
- c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- d. An ability to function on multidisciplinary teams.
- e. An ability to identify, formulate, and solve engineering problems.
- f. An understanding of professional and ethical responsibility.
- g. An ability to communicate effectively.
- h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
- i. A recognition of the need for, and an ability to engage in life-long learning.
- j. A knowledge of contemporary issues.
- k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

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 or 171/171L or 181A/181L (DP/DY)
- PHYS 170/170L and 272/272L (DP/DY)
- BIOL 171/171L (DB/DY)
- MATH 241, 242, 243, and 244 or 251A, 252A, and 253A (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 Biological Engineering degree

### College Requirements:

- NREM 310

### Programming Requirements:

- EE 110 or 160

### Science Requirements:

- BIOL 172/172L or MICR 351/351L or BE 120
- BIOL 275/275L or MICR 351/351L or MICR 485/485L
- CHEM 272/272L

### Engineering Requirements:

- CEE 270 and 271
- EE 211 and ME 311
- CEE 320 or ME 322
- BE 260, 350, 350L, 373, 437, 481, and 482
- At least 12 credits from courses BE 405, 410, 411, 420, 431, 460, 470, CEE 355, or ME 371

A minimum of 48 credits of engineering courses must be completed (excluding programming courses). A minimum grade for the prerequisites of biological engineering courses is C- unless otherwise noted. Students must 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/](http://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.

### Entrance Requirements for Biological Engineering (BE) Master of Science (MS) Programs

1. Minimum qualifications for admittance are:  
A Bachelor of Science (BS) degree from an accredited engineering program of its equivalent. A GPA of at least 3.0 on a scale of 4.0.  
\*If you have completed a BS degree in a non-engineering discipline, you may still be admitted into the program provided that you have or will complete the prerequisites in engineering and math courses.
2. All prospective students must submit scores of the GRE General Test. In special cases, submission of scores may be delayed with permission from Graduate Division. Foreign students must also submit TOEFL scores (see Graduate Bulletin for exceptions). A minimum TOEFL score of 250 on the computer-based test (or 100 on the internet-based test) is required.
3. All applicants are expected to have completed courses or equivalents in engineering, mathematics, physics, chemistry,

biology, biochemistry, and one additional upper division course in cellular or molecular biology. Students may be accepted with deficiencies in one or more of these areas, however, deficiencies must be made up during the first year of enrollment, and will not count toward graduation requirements.

### Plan A Requirements

- 21 course credits and 9 thesis research credits.
- MBBE 699 and 700 cannot be used to satisfy course credit requirements.
- 12 or more course credits must be at 600 level or above.
- 12 or more course credits must be in biological engineering; of these 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

- 27 course credits and 3 credits of MBBE 699 on a design or research project.
- MBBE 699 cannot be used to satisfy course credit requirements.
- 18 or more course credits must be at 600 level or above.
- 18 or more course credits must be in biological engineering; of these 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

Samir Khanal, Graduate Chair, Bioengineering  
Honolulu, HI 96822  
Tel: (808) 956-3812  
Fax: (808) 956-3542  
Email: khanal@hawaii.edu

### 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, bioenergy, 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 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. (Note: Graduate Division deadlines change each year.)
- Publication. Students are encouraged to publish a paper in a peer-reviewed scientific journal 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. 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 with a previous master's degree in the biosciences are required to take a minimum of three credits of 400-level (excluding 499) and nine credits of 600-level (excluding 699) courses from the list of approved courses. Students with a master's degree are required to take an additional two courses (three credits each of 400 and 600-level). The courses must be pre-approved by the major advisor and Graduate Chair. A minimum of 12 credits of MBBE 699 (directed research) and one credit of MBBE 800 are also required of all students. MBBE 800 is taken preferably in the final semester. 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. This committee will consist of five faculty members, four of which are MBBE faculty or affiliated cooperating faculty. A fifth member must be from outside the MBBE department, but the member can be an affiliated faculty. It is imperative that the PhD student consults Graduate Division website to determine if the fifth committee member is an eligible external member; failure to do so may invalidate decisions made by the committee.
- 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 UH Mānoa. 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: Frequent discussions are encouraged 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: 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. Graduate Division has a published set of guidelines required by the university. Formatting and the contents of the manuscript must satisfy these requirements, or the dissertation will not be accepted by the university.
- **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. 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

The following 400-level courses are recommended:

- MBBE 401, 402, 405, 408, 412, 483,
- BE 410, 420, 431, 460,
- BIOL 407

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, 620, 625, 650, 651, 683, 687,
- BE 606, 622, 625, 634, 638,
- CMB 621, 622,
- MICR 625, 632, 671,
- PEPS 730
- TPSS 604, 614, 640

#### Financial Assistance

Most 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

Dr. Jon-Paul Bingham  
Graduate Chair, Molecular Biosciences and Bioengineering  
University of Hawai'i at Mānoa  
Phone: (808) 956-4864  
Fax: (808) 956-3542  
Email: gcmbbe@hawaii.edu

## Molecular Biosciences and Biotechnology Program

Agricultural Science 218  
1955 East-West Road  
Honolulu, HI 96822-2279  
Tel: (808) 956-8384  
Fax: (808) 956-3542  
Email: mbbe@ctahr.hawaii.edu  
Web: cms.ctahr.hawaii.edu/Default.aspx?alias=cms.ctahr.hawaii.edu/MBBE

#### Participating Faculty

A. M. Alvarez, PhD—bacterial diseases  
J. P. Bingham, PhD—peptide biochemistry  
D. Borthakur, PhD—molecular genetics of bacteria and their interactions with plants  
D. A. Christopher, PhD—plant molecular biology, regulation of gene expression  
J. S. Hu, PhD—transgenic disease resistance  
D. Jenkins, PhD—biosensors  
C. M. Kinoshita, PhD—bioremediation  
P. S. Leung, PhD—biotechnology economics  
Q. Li, PhD—environmental biochemistry  
R. M. Manshardt, PhD—tropical fruit breeding and genetics  
P. Nerurkar, PhD—metabolic disorders, signal transduction, alternative medicine  
G. Presting, PhD—plant genomics, bioinformatics  
H. Spafford, PhD—insect biology and conservation  
W. W. Su, PhD—cell culture, biochemical engineering  
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 molecular biosciences and biotechnology

#### Student Learning Outcomes

- Understand fundamental core science concepts and ability to apply their knowledge in the field of biotechnology;
- Have the knowledge and core sets of skills that span across basic sciences and biotechnology, and mathematics portions of (STEM) education;
- Understand and identify ethical issues and social impacts associated with biotechnology, and practice ethical standards of integrity, honesty, and fairness in scientific practices and professional conduct;
- Communicate orally and in writing in a clear, well-organized manner that effectively informs and clarifies scientific principles and lab techniques to others;
- Able to solve problems using hypothesis development and experimental methods on biological systems; and
- Well prepared for employment in the critically important and dynamic biotechnology industry.

## The Academic Program

Biotechnology is dramatically influencing the agricultural, environmental, and pharmaceutical sciences. Molecular Biosciences and Biotechnology (MBB) is an interdisciplinary Bachelor of Science degree program designed to educate students in the exciting and growing field of biotechnology, which promises to be a predominant science of the 21st century. MBB graduates will be qualified for employment in agricultural, pharmaceutical, environmental clean-up, forensics, and biotechnology industries; to work in government agencies, environmental groups, and consulting firms; to teach secondary education, or to embark on graduate studies to prepare for advanced research and teaching positions.

The program provides a thorough foundation in molecular biology, biochemistry, genetics, biotechnology, and the life sciences. It serves as excellent and rigorous training for graduate and professional school.

Students tailor their studies to meet their interests by choosing electives, senior research projects, and a laboratory in the following subjects: environmental and microbial biotechnology, plant biotechnology, insect and pathogen biotechnology, and aquaculture and bioreactor biotechnology. Students participate in hands-on laboratory work culminating in research and a senior thesis. Graduates are competent for employment using modern methods such as molecular diagnostics, forensics, tissue culture, genetic engineering, microbial detection, bioremediation, algal bioenergy, marine biotechnology, proteomic, bioinformatic, and genomic analyses. They will have the skills for employment in the burgeoning biotechnology industry and for entering graduate or professional school.

## Undergraduate Study

### BS in Molecular Biosciences and Biotechnology

#### Requirements

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

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 or 241
- NREM 220 or ECON 130
- NREM 310

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

- MBBE/BIOL 304
- MBBE/BIOL 401
- MBBE 402
- MBBE 483
- MBBE 499

#### Electives

Students are required to take 24 credits of electives in the various sciences related to their interests in the environment, animals, microbiology, plants, the health sciences, crop protection, or aquaculture. The following are the approved list of electives:

- ANSC 446 Genes and Animal Biology
- ANSC/OCN 450 Aquaculture Production

- BE 150 Introduction to Biological Engineering
- BE 260 Mass and Energy Balances
- BE 373 Transport Phenomena
- BE 410 Biomass Conversion to Biofuels and Bioenergy
- BE 411/FSHN 411 Food Engineering
- BE 420 Sensors and Instrumentation for Biological Systems
- BE 431 Environmental Biotechnology
- BE 440 Bioremediation Principles and Practices
- BIOL 375/375L Genetics/Lab
- BIOL 407 Molecular Cell Biology I
- BIOL 408 Molecular Cell Biology II
- BIOL 472/MCB 472 The Biology of Cancer
- BOT 101/101L General Botany/Lab
- BOT 420 Plant Form and Function
- CHEM 273/273L Advanced Organic Chemistry
- MBBE 402 Principles of Biochemistry
- MBBE 408 Molecular Cellular Biology II
- MBBE 412 Environmental Biochemistry
- MICR 351/351L Biology of Microbes
- MICR 461 Immunology
- MICR 470 Bacterial Molecular Pathogenesis
- MICR 475/475L Bacterial Genetics/Lab
- MICR 485/485L Microbes and Their Environment/Lab
- MICR 490 Virology
- PHRM 201 Introduction to General Pharmacology
- PHRM 203 General Pharmacology
- PEPS 363 General Entomology
- PEPS 371 Genetics: Theory to Application
- PEPS 405 Plant Pathogens and Disease
- PEPS 421 Foundations of Pest Management
- PEPS 422 Biocontrol of Invasive Species
- PHRM 203 General Pharmacology
- TPSS 440 Tissue Culture/Transformation
- TPSS 453 Plant Breeding and Genetics
- TPSS 470/470L Plant Physiology
- ZOOL 320/320L Vertebrate Zoology

## Natural Resources and Environmental Management

Sherman Lab 101  
1910 East West Road  
Honolulu HI 96822  
Tel: (808) 956-7530  
Fax: (808) 956-6539  
Email: nrem1@ctahr.hawaii.edu  
Web: www.ctahr.hawaii.edu/nrem/

#### Faculty

- \*C. Chan, PhD (Chair)—agricultural and international development and environmental economics, and management
- \*K. Carlson, PhD—human dimensions of agroecosystems and natural resources
- \*L. J. Cox, PhD—community economic development
- \*S. E. Crow, PhD—soil ecology and biogeochemistry
- \*C. I. Evensen, PhD—natural resource management, environmental quality
- \*J. B. Friday, PhD—tropical forestry/agroforestry extension
- \*T. W. Idol, PhD—tropical forestry/agroforestry
- \*J. J. K. Leary, PhD—invasive species control
- \*C. M. Litton, PhD—forest ecology and management, biogeochemistry



- \*T. Miura, PhD—geospatial analysis, remote sensing
- S. Y. Nagano, MS—4-H youth program, county extension
- \*K. L. L. Oleson, PhD—ecological economics, ecosystem services
- \*M. Price, PhD—behavioral ecology, conservation genetics
- \*P. C. Trauernicht, PhD—wildfire management extension
- \*Y. Tsang, PhD—ecohydrology
- \*M. D. B. Vaughan, PhD—collaborative resource management and environmental education

### Cooperating Graduate Faculty

- K. M. Burnett, PhD—invasive species assessment and management (SSRI)
- J. Cusick, PhD—sustainability and tourism (WRRC)
- J. Deenik, PhD—soil quality and fertility (TPSS)
- J. DeFrank, PhD—herbicide management (TPSS)
- A. El-Kadi, PhD—groundwater hydrology (GG/WRRC)
- T. Giambelluca, PhD—climatology, hydrology (GEOG)
- N. V. Hue, PhD—organic cycling (TPSS)
- Q. Li, PhD—environmental chemistry (MBBE)
- Y. Li—tropical forest ecology and management (UH Hilo)
- T. Radovich, PhD—sustainable farming (TPSS)
- H. Valenzuela, PhD—vegetation physiology and management (PEPS)

### Affiliate Graduate Faculty

- G. Bruland, PhD—soil and water conservation (Principia College)
- J. Fox, PhD—social forestry (East-West Center)
- A. Friedlander, PhD—biogeography, fisheries (National Geographic)
- C. Giardina, PhD—forest ecology (IPIF-USPA-FS)
- S. Gray, PhD—human ecology (MSU)
- S. Hess, PhD—wildlife management (USGS)
- C. Lepczyk, PhD—ecosystem management, wildlife ecology, landscape ecology (Auburn)
- J. Lynch, PhD—marine environmental science (NIST)
- R. Mackenzie—aquatic ecology (USDA Forest Service)
- H. McMillen, PhD—community-based natural resource management, social-ecological systems, global change (USDA Forest Service)
- M. Pan—fishery economics (NOAA Fisheries)
- C. Ray, PhD—ground water hydrology and chemistry (U of Nebraska-Lincoln)
- A. Strauch, PhD—watershed hydrology (State DLNR)
- K. Winter, PhD—Hawaiian ethnobotany, native ecosystem restoration, ahupuaa models, integrated mauka to makai local level resource management (Limahuli Garden & Preserve)

**Degrees and Certificates Offered:** BS, MS, MEM, and PhD in natural resources and environmental management, Graduate Resource Management Certificate (see the “Interdisciplinary Programs” section)

## The Academic Program

The Natural Resources and Environmental Management (NREM) program emphasizes the science and management of natural resources and their interlinkages 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 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, planners, and communities. 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 NREM undergraduate program advisor or a CTAHR academic advisor to determine the student’s interest and preparation for the NREM major. After choosing a pathway and specialization, the student is then assigned to a permanent faculty advisor, with whom he or she meets every semester to plan courses and chart progress toward graduation. The faculty advisor assists the student in arranging an internship (NREM 492), selection of elective courses, career advising, and his or her professional development. Students must also meet with a CTAHR academic advisor each semester.

### 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 120 credit hours, with at least 45 credits in upper division (300+ level). Regardless of selected pathway and 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:

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

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

- NREM 102
- NREM 251
- NREM 220 or ECON 130
- NREM 301/301L
- NREM 302
- NREM 310
- NREM 477
- NREM 492
- NREM 494

### Specializations and Their Requirements

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

#### Natural Science Pathway

This pathway focuses on the biophysical and natural science aspects of resource management. Course requirements include:

- PHYS 151/151L
- CHEM 162/162L
- NREM/TPSS 304
- 18 upper division credits in a natural resource specialization area, with at least one course (3 credits) 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/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

#### Social Science Pathway

This pathway emphasizes the social sciences and business/public management skills. Requirements include courses in:

- Business/Decision-making (3 credits)
- Community Resource Management (3 credits)
- Quantitative Skills (3 credits)
- Upper division electives (21 credits), including at least 9 credits in a natural resource area

The student's advisor helps with the selection of and approves courses to meet these requirements. For information on a Bachelor Degree Program Sheet, go to [www.manoa.hawaii.edu/ovcaa/programsheets/](http://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: MS (Plans A and C), Master's of Environmental Management (MEM), and PhD degrees in Natural Resources and Environmental Management; a university-wide Graduate Resource Management Certificate; and a university-wide graduate degree specialization in Ecology, Evolution, and Conservation Biology.

The NREM graduate program brings together natural and social scientists to offer an integrative and interdisciplinary program 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. The NREM curriculum emphasizes the application of physical, biological, and social sciences to the conservation and sustainable management 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. 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.

Students are expected to acquire quantitative reasoning, critical thinking, and advanced skills that enable them to solve contemporary resource use and environmental problems and to assist in sound policy development and implementation. NREM graduates should be skilled in addressing natural resources and environmental policy and management issues of the competing needs of diverse clientele and communities. NREM graduates are expected to serve as professional leaders in natural resources and environmental management and policy, academic teaching and research, 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.

Natural resources 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. As such, NREM has a diverse mix of domestic and international graduate students.

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 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 research, and effectively perform outreach and educational activities.

Examples of specialization areas include but are not limited to: forestry, plant ecology & conservation, wildlife ecology & conservation, soil & water conservation, coastal ecology & management, GIS & remote sensing, watershed hydrology, natural resource planning, environmental policy, cultural resources management, community resource management, environmental organizing & advocacy, and green enterprises & sustainability.

The student's advisor and thesis/dissertation committee will assist in choosing appropriate course work and research, or other activities, to fully develop a specialization area. Students are expected to declare a specialization area by the completion of their first year in the department. It is, however, the responsibility of students to know and observe all regulations and procedures relating to the program as well as those of UH Mānoa and Graduate Division.

## 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, expected minimum GRE score of 302-308 combined Verbal and Quantitative Reasoning (equivalent to 1,100-1,200 on the prior scale), or other documents. These criteria are specified in your letter of acceptance, and should be discussed immediately with your advisor upon matriculation. It is expected that students 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 (but see below for admission to the PhD degree without a BS degree).

NREM requires prior completed course work (with a grade of C or higher) that is equivalent to or higher than NREM 203, 220 (or ECON 130), 310, CHEM 151, and BIOL 171. Students who do not have course work in one or more of these areas may be accepted into the program, but will be expected to make up course deficiencies within their first 1-2 semesters on campus and complete Form 1.

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 minimum required IELTS score is: (a) MS student: 6.0

and (b) PhD student: 7.0. The TOEFL/IELTS requirement applies to all foreign students, except those who are native speakers of English or 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., Ireland, Canada, New Zealand, Singapore, or Australia. Students with low TOEFL/IELTS scores are required to enroll in remedial ELI (English Language Institute, [www.hawaii.edu/eli/](http://www.hawaii.edu/eli/)) courses.

## Students Applying to PhD Program

### (1) Admission to PhD After Finishing NREM MS

An NREM PhD student who also completed his or her MS in NREM and has subsequently been accepted into the NREM PhD program has the option to take directed reading (NREM 699) for half of the required elective credits (12 of the 24) if NREM courses that are applicable to the student's degree have already been taken as part of the MS degree plan. At least 6 of the non-NREM 699 credits must be for graduate research methods courses. Also, the student is still required to take all 7 credits of NREM PhD core classes. In the case where a student took some/all of these core credits as electives during their MS degree program, an equivalent number of 600-level credits (but not NREM 699) must be taken.

### (2) Admission to PhD Without Finishing NREM MS

A currently enrolled NREM MS student can be admitted into NREM's PhD program prior to completing their MS degree if ALL of the following criteria are met:

- Unanimous approval by the student's MS committee
- Record of excellent academic achievement including, at a minimum:
  - Maintaining a GPA >3.5 in the MS NREM program
- The student has the proven ability to undertake independent research, which can be demonstrated by ALL of the following:
  - Authored/co-authored (student as 1st author) ≥ 1 presentation at a national or international professional conference
  - Authored/co-authored (student as 1st author) ≥ 1 peer reviewed journal article
  - Accrued ≥ 2 years of meaningful research experience at school, jobs etc.

### (3) Admission to PhD From BS

A student with a BS degree can be admitted directly into NREM's PhD program if ALL of the following criteria are met:

- A faculty member agrees to advise the student and commits to at least 3 years of funding
- Record of excellent academic achievement including, at a minimum:
  - Undergraduate GPA >3.5
  - Average verbal, quantitative and written GRE scores >75th percentile
- The student has the proven ability to undertake independent research, which can be demonstrated by ALL of the following:
  - Authored/co-authored (student as 1st author) a minimum of 1 presentation at a national or international professional conference
  - Authored/co-authored (student as 1st author) a minimum of 1 peer reviewed journal article
  - Accrued at least 2 years of meaningful research experience at school, jobs, or internships



## Advising

Admitted students will check in with his or her advisor upon arriving on campus. An advisor has been identified for every student based on the student's stated interest and consent of the advisor. If you do not know who your advisor is, check with the NREM office staff or the graduate chair immediately. 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 two 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; and Plan B is only for students with exceptional prior work experience that requires a minimum of two semesters of full-time resident study at UH Mānoa and a final written and oral comprehensive examination.

Once admitted, MS students must select a specialization (Plan A) 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 or her selected Plan option or specialization/concentration area.

The course requirements for each plan are:

#### Plan A

In addition to the Primary MS Core, a set of electives and thesis credits are required for a total of 30 credits. Electives provide background in research methods and depth in the student's area of specialization. The remaining credit requirements will be met with thesis credits (NREM 700) for conducting the research project. Once the thesis topic is finalized, a research proposal must be approved by the committee. An oral defense of the proposal in front of the thesis committee is also required for final approval of the thesis topic. A public thesis defense is also required, and an announcement with thesis abstract, defense date, and location must be sent to the graduate program chair, departmental secretary, and Graduate Division at least 2 weeks in advance.

#### Primary MS Core (9 credits):

NREM 600 (4), 601 (4), 701 (1)

#### Electives (15 credits):

Course in graduate research methods (400-level or above, 3); NREM graduate courses (500-level and above, 6); Other graduate courses for specialization from within or outside of NREM (6); where all 6 credits can be satisfied by 400-level course credits, however, this reduces to 3 credits if a 400-level course(s) is taken to fulfill the research methods requirement.

#### Thesis Option (6 credits):

NREM 700 Thesis (6)

#### Plan C

Plan C is for 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)

#### Master's of Environmental Management (MEM)

MEM is a course-driven professional degree that requires a total of 36 credits. Students are required to declare a concentration from one of four possible concentration areas (see below). Courses include the Primary MS Core (9 credits), research methods (3 credits), a minimum of 9 elective credits from the chosen concentration area, a minimum of 3 elective credits from each of the other three concentration areas, and a 6 credit capstone experience.

#### Primary MEM Core (9 credits):

Same as Plan A primary core.

#### Research Methods (3 credits):

Course in graduate research methods (400-level or above, 3).

#### Concentration Areas (total 18 credits):

MEM students must select a concentration area from the following: Geospatial Analysis and Modeling, Environmental Policy and Economics, Land and Water Resource Management, and Applied Terrestrial Ecology. Students are required to take a minimum of 9 credits from their concentration area and 3 credits from each of the other areas. Of the 18 elective credits required: (1) at least 12 credits must be NREM courses; and (2) a maximum of 12 credits of upper-division undergraduate course credits (400-level) are allowed, however, this reduces to 9 credits if a 400-level course(s) is taken to fulfill the research methods requirement. The list is not comprehensive, and substitutions will be considered via a written petition from the faculty advisor to the curriculum committee.

#### Geospatial Analysis & Modeling

- NREM 477, 664, 677, GEOG 470, 472, PLAN 473, 673, GEOG/TPSS 680

#### Environmental Policy and Economics

- NREM 420, 611, 627, 637, 658, 671, NREM/ECON/TPSS 429, BOT/HWST 458, GEOG 413, 621, 622, GEOG/PLAN 637, PLAN 620, 625, 628, 640, 671

#### Land & Water Resource Management

- NREM 461, 463, 467, 612, 660, 662, 665, LWEV 588, GEOG 423, 618, HWST 650, HWST/BOT 457, 459, BOT/ZOOL 450, OCN 457, ZOOL 410

#### Applied Terrestrial Ecology

- NREM 450, 480, 680, 682, 685, NREM/BOT/ZOOL 690, TPSS 481, 604, BOT 444, 454, 456, 651, 661, ZOOL 439

#### Capstone Experience (6 credits):

A capstone experience is required for all MEM students. The capstone experience consists of: (1) NREM 695 (1 cr), to be taken when the student is preparing their proposal; and (2) NREM 696 (3 cr) and NREM 699 (2 cr; register with faculty advisor), to be taken when the student has completed their

capstone experience and is writing up their final document. All capstone experiences require approval from the MEM Capstone Panel, which consists of the faculty advisor, the NREM 695 course instructor, and an at-large Panel member.

The Capstone Experience requirement may be fulfilled in a number of ways, based on each individual student's interests. In as much, it will vary from student to student, but typical capstone experiences will involve: (1) an internship/coop/special field experience; (2) an investigation of a special topic; and/or (3) development of a project, directed readings/study, or a research project. Each student is expected to take the primary role in identifying and organizing their capstone experience. In meeting this requirement, it will be important for students to demonstrate that they are getting an "integrative" experience in natural resources and environmental management. Each student will be required to give a public proposal and defense presentation, and provide a written proposal and final document on their capstone experience, both of which will be evaluated by the MEM Capstone Panel.

### **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 with academic records that do not match NREM core requirements will be expected to incorporate these into their PhD program. 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 or her selected specialization area. In addition, a set of electives will 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 (3)
- NREM 612 (3)
- NREM 701 (1)

#### **Electives (24 credits)**

- Graduate research methods (500-level or above, 6)
- NREM graduate courses (500-level or above, 9)
- Other graduate courses for specialization from within or outside of NREM (9); a maximum of 9 credits of upper-division undergraduate course credits (400-level) allowed from within or outside of NREM

#### **Dissertation (1 credit)**

- NREM 800 (1)

#### **Comprehensive Examination**

The final outcome of the comprehensive examination is the acceptance of the student to the PhD candidacy in NREM. Based on this examination, the student's committee will determine if the student: (1) is ready, (2) needs to take more courses to remediate deficiencies in her or his training, or (3) that the student is not fit for the NREM PhD program. In the process of administering the examination, the committee will test the rigor of the student's training as: (1) a scientist

in general (that the student can follow the scientific method and procedure to address a research problem and also has the analytical skills to conduct research), (2) a scientist in NREM (has in-depth knowledge of what makes her or him 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, Geology and Geophysics, or Geography), and (3) a scientist in her or 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: (1) his or her specialty (i.e., hydrology, forest ecology and management), (2) general topics related to NREM (i.e., core courses, background knowledge), (3) knowledge of general research methods (i.e., statistics, analysis methods, etc.), and (4) the proposed dissertation research.

## **Plant and Environmental Protection Sciences**

Gilmore 310  
3050 Maile Way  
Honolulu, HI 96822  
Tel: (808) 956-7076  
Fax: (808) 956-2428  
Email: [peps@ctahr.hawaii.edu](mailto:peps@ctahr.hawaii.edu)  
Web: [www.ctahr.hawaii.edu/peps/](http://www.ctahr.hawaii.edu/peps/)

### **Faculty**

- \*K. H. Wang, PhD (Chair)—nematology, ecological pest management
- \*M. Arif, PhD—host bacterial interaction, bacterial genomics
- \*W. B. Borth PhD—plant virology, mycoplasmas
- \*Z. Cheng, PhD—turfgrass and landscape pest management  
environmental bio-indicators, urban soil ecology and environmental sciences
- R. Curruthers, PhD—population ecology, integrated pest management  
biological control
- J. Dupuis, PhD—evolutionary biology and speciation, insect  
systematics, population genetics and genomics
- C. Ewing, PhD—forest entomology
- \*S. A. Ferreira, PhD—crop protection, extension education
- \*J. K. Grace, PhD—urban entomology, termite and social insect  
biology and control, insect behavior
- \*J. R. Graham, PhD—pollinator management, native bee conservation,  
bee health and biodiversity
- R. Guitierrez, PhD—integrated pest management
- \*W. Haines, PhD—insect ecology life history, plant-insect interactions,  
population genetics, conservation of native insects
- R. T. Hamasaki, MS—fruit and vegetable crops extension education  
(Hawai'i Cooperative Extension Service)
- \*J. Hu, PhD—virology
- \*M. Kawate, PhD—pesticide registration
- \*P. Krushelnicky, PhD—entomology, invasion biology
- \*M. Melzer, PhD—agrosecurity, virology
- C. Mogren, PhD—pollination biology
- \*R. H. Messing, PhD—insect ecology and biological control (Kaua'i)

Agricultural Research Center)

I. Pulakkaru Thodi, PhD—integrated pest management

\*D. Rubinoff, PhD—insect systematics and ecology, invasive species, conservation biology

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)

\*B. S. Sipes, PhD—nematology, alternative control methods

\*H. Spafford, PhD—integrated pest management, biological control and biosecurity

J. S. Sugano, MS—extensions education (O'ahu Cooperative Extension Service)

\*M. Tian, PhD—molecular host-pathogen interactions

\*J. Y. Uchida, PhD—fungal pathology, biological control of diseases, environmental impacts

H. Valenzuela, PhD—sustainable, organic products

\*E. Villalobos PhD—pollinator management, honeybee health

S. Watanabe, PhD—agrosecurity

\*M. G. Wright, PhD—integrated pest management, tropical fruits and nuts, insect ecology, biological control

### Cooperating Graduate Faculty

L. Arita-Tsutsumi, PhD—insect behavior, honeybee ecology (UH Hilo)

K. Y. Kaneshiro, PhD—systematics, evolution, insect behavior

S. Marahatta, PhD—sustainable agriculture, ecology and nematology (UH Kauai)

M. Medeiros, PhD—mosquito ecology

M. Shintaku, PhD—virology (UH Hilo)

### Affiliate Graduate Faculty

N. Evenhuis, PhD—systematics of Diptera (Bishop Museum)

P. A. Follett, PhD—commodity quarantine treatments, tropical tree fruit IPM (USDA-ARS, Hilo)

S. Geib, PhD—genomic analysis

L. Kaufman, PhD—integrated pest management, biological control, risk assessment

N. Liquido, PhD—fruit flies, entomology

R. Myers, PhD—plant pathology and nematology (USDA-ARS Hilo)

R. I. Vargas, PhD—ecology, mass-rearing techniques (USDA-ARS, Hilo)

A. Vorsino, PhD—GIS and spatial modeling (U.S. Fish and Wildlife Service)

**Degrees Offered:** BS in tropical agriculture and the environment with specialization in invasive species management, 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 established and invasive plants, 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. The need to protect our natural resources and the environment using methods with low non-target impacts have resulted in a focus on using biological control, integrated pest management, cultural, traditional, 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 encompasses many cropping niches and natural environments 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.

The faculty in the PEPS department use cutting-edge research tools to address the challenge of plant and environmental protection and food security and develop solutions for rational pest management and conservation of endangered species that have impact locally and globally. Through interaction with faculty from various disciplines, students are presented with great educational opportunities through a BS degree in Tropical Agriculture and the Environment with a specialization in Invasive Species Management, MS, and PhD degrees in Entomology, and Tropical Plant Pathology. Students are 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 Departments of Tropical Plants and Soil Sciences and Natural Resources and Environmental Management in CTAHR, the Ecology, Evolution, and Conservation Biology Program; Harold L. Lyons Arboretum; Hawai'i Agriculture Research Center; State of Hawai'i Departments of Agriculture and Department of Land and Natural Resources; B. P. Bishop Museum; Agricultural Research Service of the U.S. Department of Agriculture; Animal and Plant Health Inspection Service of the U.S. Department of Agriculture; Forest Service of the U.S. Department of Agriculture, and U.S. Geological Service.

### Advising/Mentorship

Undergraduates are required to consult with a CTAHR advisor prior to registration each semester. Go to [www.ctahr.hawaii.edu/ugadvising](http://www.ctahr.hawaii.edu/ugadvising) for more information. Academic advisors are available by appointment only, Monday-Friday from 8:30 a.m.-3:30 p.m. (except holidays). Appointment website: [ctahradv.youcanbook.me](http://ctahradv.youcanbook.me). Gilmore Hall, first floor, email: [ctahradv@hawaii.edu](mailto:ctahradv@hawaii.edu).

Graduate students are advised initially by a research program advisor or by the department's graduate program chairperson.

## Undergraduate Study

### BS Degree

The Departments of Tropical Plant and Soil Sciences and Plant and Environmental Protection Sciences jointly offer a BS degree in Tropical Agriculture and the Environment (TAE). Students in this program complete a common core of courses taught by faculty in both departments and then specializations in one or more of the following areas:

1. environmental soil science,
2. invasive species management,
3. landscape horticulture,
4. plant physiology and genetics,



## 5. plant production and management.

Students who undertake this program of study will:

1. Demonstrate understanding of the science of agriculture and its interaction with the environment from molecules to ecosystems.
2. Demonstrate the ability to critically evaluate scientific evidence, knowledge and issues associated with agriculture in a dynamic world.
3. Demonstrate the ability to identify problems associated with agroecosystems and apply the scientific method to develop solutions.
4. Demonstrate proficiency in oral and written communication for both professional and lay audiences.

A student is required to complete 120 credits to graduate with a BS in TAE.

Note: The Department of Plant and Environmental Protection Sciences formerly offered a BS degree. However, there is no admittance to the BS in Plant and Environmental Protection Sciences degree effective Fall 2016. Students interested in study of invasive species management should enroll in the BS in Tropical Agriculture and the Environment (TAE) and specialize in Invasive Species Management.

### Requirements

Students must complete the UH Mānoa General Education Requirements, alternatives are available to the Hawaiian/ Second Language requirement. An updated list of the courses recommended to satisfy the requirements is available from the undergraduate advisor. The college has a core consisting of the following courses:

- NREM 310 or HDFS 380/380L
- Capstone or Internship (TPSS 492/492L or PEPS 495)

The department has a core consisting of the following courses:

- TPSS 200
- BIOL 265 or PEPS 210
- TPSS 304
- TPSS 470/470L
- PEPS 421
- TPSS/PEPS 499

### Specialization in Environmental Soil Science

Students are prepared to effectively manage soils for the production of agricultural commodities and preservation of this important natural resource for human uses and environmental conservation. Students understand the chemical and biological processes that govern soil formation and nutrient cycling.

Students selecting this option need to take BIOL 171/171L, BIOL 172/172L, CHEM 161/161L and 162/162L (or their equivalent), PHYS 151, and Calculus I (MATH 215) and TPSS 492/492L. Some of these courses will fulfill part of the Natural Science requirement of the UH Mānoa General Education Requirements. Some of these courses are considered prerequisite to some courses in the major.

### Major Courses (Specialization in Environmental Soil Science)

The following courses are required for this specialization.

- TPSS 435
- TPSS 450
- TPSS 460
- TPSS 475

### Electives

The student must take 18 credits from 14 elective courses for this specialization. The options available are listed on the Bachelor Degree Program Sheet, [www.manoa.hawaii.edu/ovcaa/programsheets/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

### Specialization in Invasive Species Management

Students who specialize in invasive species management are prepared to design and implement pest management programs and conduct basic and applied research using multidisciplinary approaches. Students receive interdisciplinary education in entomology, plant pathology, weed science, and invasive species management.

Students selecting this option need to take MATH 140 or NREM 203, BIOL 171/171L and BIOL 172/172L (or their equivalent), and CHEM 161/161L and CHEM 162/162L (or their equivalent) and PEPS 495. Some of these courses will fulfill part of the Natural Science requirement of the UH Mānoa General Education Requirements. Some of these courses are considered prerequisite to some courses in the major.

### Major Requirements (Specialization in Invasive Species Management)

The following courses are required for this specialization:

- PEPS 350
- PEPS 363/363L
- PEPS 405
- PEPS 422
- PEPS 430
- TPSS/PEPS 481

### Electives

The student must take 12 credits from a list of 8 courses. The options available are listed on the Bachelor Degree Program Sheet, [www.manoa.hawaii.edu/ovcaa/programsheets/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

### Specialization in Landscape Horticulture

The landscape horticulture specialization prepares 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.

Students selecting this option need to take MATH 140 or NREM 203, BIOL 171/171L and BIOL 172/172L (or their equivalent), and CHEM 161/161L and CHEM 162/162L (or their equivalent) and TPSS 492/492L. Some of these courses will fulfill part of the Natural Science requirement of the UH Mānoa General Education Requirements. Some of these courses are considered prerequisite to some courses in the major.

### Major Requirements (Specialization in Landscape Horticulture)

The following courses need to be taken for this specialization:

- TPSS 354
- TPSS 463
- TPSS 481
- PEPS 363/363L
- PEPS 405

## Electives

The student must take 15 credits from a list of over 20 courses. The options available are listed on the Bachelor Degree Program Sheet, [www.manoa.hawaii.edu/ovcaa/programsheets/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

## Specialization in Plant Physiology and Genetics

Specializing in plant physiology and genetics allows students to cross the traditional boundaries that have separated genetics, plant physiology, molecular biology, and their application to crop production. By linking laboratory approaches and plant production systems through the application of plant biotechnology students learn to solve multi-disciplinary problems. Students can select courses that allow concentration on genetic engineering or whole plant physiology and plant breeding to address real-world problems.

Students selecting this option must take MATH 140 or NREM 203, BIOL 171/171L, BIOL 172/172L, and CHEM 161/161L, 162/162L and TPSS 492/492L. Some of these courses will fulfill part of the Natural Science requirement of the UH Mānoa General Education Requirements. Some of these courses are considered prerequisite to some courses in the major.

## Major Courses (Specialization in Plant Physiology and Genetics)

Students are required to take 10 courses (30 credits) from a list of over 30 choices. The available options are listed on the Bachelor Degree Program Sheet. For information on a Bachelor Degree Program Sheet, [www.manoa.hawaii.edu/ovcaa/programsheets/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

## Electives

Students may choose from the array of courses, offered on an advising list of courses to fulfill the university credit requirement for graduation. Advisors will be available to assist students in selecting courses that prepare students for a career in plant sciences and genetics.

## Specialization in Plant Production and Management

Students are prepared to produce, manage, and market plants grown as crops or in landscapes with an emphasis on productivity with appropriate pest and disease management. Students learn to solve horticultural problems using evidence-based methods.

Students selecting this option need to take MATH 140 or NREM 203, BIOL 171/171L, BIOL 172/172L, and CHEM 161/161L and 162/162L and TPSS 492/492L. Some of these courses will fulfill part of the Natural Science requirement of the UH Mānoa General Education Requirements. These courses are considered prerequisite to some courses in the major.

## Major Courses (Specialization in Plant Production and Management)

The following courses are required for this specialization:

- TPSS 364
- TPSS 420
- TPSS/PEPS 481
- PEPS 363
- PEPS 363L
- PEPS 405

In addition, the student must take 6 courses from a list of over 30 choices. The options available are listed on the Bachelor Degree Program Sheet, [www.manoa.hawaii.edu/ovcaa/](http://www.manoa.hawaii.edu/ovcaa/)

[programsheets/](#).

## Elective Courses

Students may choose from the array of courses offered on an advising list of courses to fulfill the university credit requirement for graduation. Advisors will be available to assist students in selecting courses that prepare students for a career in horticultural crop production and management.

## Graduate Study

### Entomology

MS and PhD degrees are offered in the entomology program. Courses are offered in biological control of insect pests and weed, insect ecology, insect physiology, insect transmission of plant pathogens, systematics and phylogenetics, and various special topics in genomics, conservation and 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.

To apply for the graduate program in entomology, a student must complete the University Graduate Student application, the Graduate Record Examination and any English language proficiency examinations required by the university. Each student should communicate with and identify a graduate advisor from among the entomology graduate faculty and prepare a statement of objectives that describes the goals for and interests in entomology. This statement of objectives and three confidential letters of reference should be 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; (3) acquire and demonstrate communication and literacy skills; (4) write and defend a thesis of entomological research; and (5) present findings of their research in oral and/or poster formats in scientific form and publish the results of their research in peer-reviewed journals.

Students shall develop into competent and knowledgeable biologists. They demonstrate this competency by having a basic understanding of entomology, insect ecology, phylogeny, and pest management.

### **MS Plan A (Thesis)**

- 16 credit hours of course work including seminars
- 2 credit hours of PEPS 690
- 12 credit hours of PEPS 700
- 2 credit hours of PEPS 799
- 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
- 1 credit hour of PEPS 799 (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 original 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; (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
- 2 credit hours of PEPS 799 (CR/NC)
- 1 credit hour of PEPS 800 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.

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.

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 Division 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 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, 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 (CR/NC).
- Comprehensive and final defense examinations.
- 1 credit hour of 800 during semester of graduation.
- Submission of acceptable dissertation.

## Tropical Plant and Soil Sciences

St. John 102  
3190 Maile Way  
Honolulu, HI 96822-2279  
Tel: (808) 956-8351  
Fax: (808) 956-3894  
Email: [tpss@ctahr.hawaii.edu](mailto:tpss@ctahr.hawaii.edu)  
Web: [www.manoa.hawaii.edu/ctahr/tpss/](http://www.manoa.hawaii.edu/ctahr/tpss/)

### Faculty

- \*R. E. Paull, PhD (Chair)—plant growth & development, postharvest handling
- \*K. W. Leonhardt, PhD—ornamentals, crop improvement
- \*A. Ahmad, PhD
- \*T. D. Amore, PhD—floriculture breeding
- \*B. C. Baldos, PhD—landscape and ornamental horticulture
- \*A. Cho, PhD—sustainable farming systems, tropical fruits and nuts
- \*J. Deenik, PhD—soil fertility, soil management
- \*J. DeFrank, PhD—weed science
- \*M. Kantar, PhD—plant breeding, domestication, ecological, and landscape genomics/genetics, agroecology
- \*A. Kaufman, MLA, PhD—landscape systems, design and management, environmental psychology
- \*K. D. Kobayashi, PhD—floriculture and fruit physiology, computer modeling
- \*N. K. Lincoln, PhD—indigenous crops and cropping systems
- \*R. M. Manshardt, PhD—tropical fruit breeding and genetics

- \*S. C. Miyasaka, PhD—alternative crops, plant nutrition
- \*M. G. Muszynski, PhD—genetics, plant development, genomics
- \*S. C. Nelson, PhD—epidemiology, extension education
- \*H. V. Nguyen, PhD—soil chemistry
- \*N. Nguyen, PhD—soil microbiology, metagenomics
- \*R. Ogoshi, PhD—agronomy and soil science
- \*T. Radovich, PhD—vegetables, sustainable farming
- \*M. R. Sandlin, PhD—public opinion research
- \*A. A. Saulo, PhD—food technology extension, food safety and quality
- \*A. M. Wiczonek, PhD—molecular ecology, population genetics, biotechnology
- \*R. S. Yost, PhD—soil-plant relations, soil management, geospatial analysis

### Cooperating Graduate Faculty

- D. Borthakur, PhD—plant-microbe interactions, plant biotechnology
- A. El-Kadi, PhD—hydrology
- C. I. Evensen, PhD—water quality extension, environmental education
- J. Leary, PhD—invasive weed management
- W. S. Sakai, PhD—ultrastructure, physiological plant anatomy
- M. Shintaku, PhD—plant-virus interactions, plant pathology
- R. Sutherland, PhD—geomorphology, soil erosion, water quality
- M. J. Tanabe, PhD—in vitro propagation, turf management, plant propagation
- M. Wright, PhD—integrated pest management, tropical fruits and nuts, insect ecology, biological control

### Affiliate Graduate Faculty

- H. C. Bittenbender, PhD—coffee, kava and cacao physiology and management
- M. M. M. Fitch, PhD—tissue culture, genetic engineering
- T. Matsumoto, PhD—horticulture
- C. N. Nagai, PhD—sugar cane genetics and tissue culture
- D. Ragone, PhD—ethnobotany, conservation
- A. Vorsino, PhD—GIS expertise in landscape genetic analysis
- M. Wall, PhD—postharvest, product quality

### Emeritus Faculty

- R. A. Criley, PhD—floriculture, flowering physiology, plant propagation

**Degrees Offered:** BS in tropical agriculture and the environment, MS and PhD in tropical plant and soil sciences, minor in plant production and management, agribusiness certificate

### Program Goals

Upon graduation, students will be able to:

- Integrate discipline- and thematic-specific knowledge of basic and applied plant and soil sciences for its analysis, evaluation and application in the improvement, management, and production of sustainable managed and natural ecosystems.
- Demonstrate an awareness of practices that minimize damage to the environment and ensure a safe sustainable 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 sustainable 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 sustainable 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, work in a commercial industry via our internship program, and completing the Agribusiness Certificate. 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/Mentorship**

Tropical Plant and Soil Sciences  
St. John Hall Room 102  
3190 Maile Way  
Honolulu, HI 96822-2279  
Tel: (808) 956-8909  
Fax: (808) 956-3894  
Email: leonhard@hawaii.edu

Undergraduates are required to consult with a CTAHR advisor prior to registration each semester. Go to [www.ctahr.hawaii.edu/ugadvising](http://www.ctahr.hawaii.edu/ugadvising) for more information. Academic advisors are available by appointment only, Monday-Friday from 8:30 a.m.-3:30 p.m. (except holidays). Appointment website: [ctahradv.youcanbook.me](http://ctahradv.youcanbook.me). Gilmore Hall, first floor, email: [ctahradv@hawaii.edu](mailto:ctahradv@hawaii.edu).

Graduate students are advised initially by a research program advisor or by the department's graduate program chairperson., Dr. Kenneth Leonhard, [leonhard@hawaii.edu](mailto:leonhard@hawaii.edu).

## **Undergraduate Study**

### **BS Degree**

The Departments of Tropical Plant and Soil Sciences and Plant and Environmental Protection Sciences jointly offer a BS degree in Tropical Agriculture and the Environment (TAE). Students in this program complete a common core of courses taught by faculty in both departments and then specializations

in one or more of the following areas:

1. environmental soil science,
2. invasive species management,
3. landscape horticulture,
4. plant physiology and genetics,
5. plant production and management.

Students who undertake this program of study will:

1. Demonstrate understanding of the science of agriculture and its interaction with the environment from molecules to ecosystems.
2. Demonstrate the ability to critically evaluate scientific evidence, knowledge and issues associated with agriculture in a dynamic world.
3. Demonstrate the ability to identify problems associated with agroecosystems and apply the scientific method to develop sustainable solutions.
4. Demonstrate proficiency in oral and written communication for both professional and lay audiences.

A student is required to complete 120 credits to graduate with a BS in TAE.

Note: The Department of Plant and Environmental Protection Sciences formerly offered a BS degree. However, there is no admittance to the BS in Plant and Environmental Protection Sciences degree effective Fall 2016. Students interested in study of invasive species management should enroll in the BS in Tropical Agriculture and the Environment (TAE) and specialize in Invasive Species Management.

### **Requirements**

Students must complete the UH Mānoa General Education Requirements, alternatives are available to the Hawaiian/Second Language requirement. An updated list of the courses recommended to satisfy the requirements is available from the undergraduate advisor. The college has a core consisting of the following courses:

- NREM 310 or HDFS 380/380L
- Capstone or Internship (TPSS 492/492L or PEPS 495)

The department has a core consisting of the following courses:

- TPSS 200
- BIOL 265 or PEPS 210
- TPSS 304
- TPSS 470/470L
- PEPS 421
- TPSS/PEPS 499

### **Specialization in Environmental Soil Science**

Students are prepared to sustainably manage soils for the production of agricultural commodities and preservation of this important natural resource for human uses and environmental conservation. Students understand the chemical and biological processes that govern soil formation and nutrient cycling.

Students selecting this option need to take BIOL 171/171L, BIOL 172/172L, CHEM 161/161L and 162/162L (or their equivalent), PHYS 151, and Calculus I (MATH 215) and TPSS 492/492L. Some of these courses will fulfill part of the Natural Science requirement of the UH Mānoa General Education Requirement. Some of these courses are considered prerequisite to some courses in the major.

## Major Courses (Specialization in Environmental Soil Science)

The following courses are required for this specialization.

- TPSS 435
- TPSS 450
- TPSS 460
- TPSS 475

## Electives

The student must take 18 credits from 14 elective courses for this specialization. The options available are listed on the Bachelor Degree Program Sheet, [www.manoa.hawaii.edu/ovcaa/programsheets/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

## Specialization in Invasive Species Management

Students who specialize in invasive species management are prepared to design and implement pest management programs and conduct basic and applied research using multidisciplinary approaches. Students receive interdisciplinary education in entomology, plant pathology, weed science and invasive species management.

Students selecting this option need to take MATH 140 or NREM 203, BIOL 171/171L and BIOL 172/172L (or their equivalent), and CHEM 161/161L and CHEM 162/162L (or their equivalent) and PEPS 495. Some of these courses will fulfill part of the Natural Science requirement of the UH Mānoa General Education Requirement. Some of these courses are considered prerequisite to some courses in the major.

## Major Requirements (Specialization in Invasive Species Management)

The following courses are required for this specialization:

- PEPS 350
- PEPS 363/363L
- PEPS 405
- PEPS 422
- PEPS 430
- TPSS/PEPS 481

## Electives

The student must take 12 credits from a list of 8 courses. The options available are listed on the Bachelor Degree Program Sheet, [www.manoa.hawaii.edu/ovcaa/programsheets/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

## Specialization in Landscape Horticulture

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

Students selecting this option need to take MATH 140 or NREM 203, BIOL 171/171L and BIOL 172/172L (or their equivalent), and CHEM 161/161L and CHEM 162/162L (or their equivalent) and TPSS 492/492L. Some of these courses will fulfill part of the Natural Science requirement of the UH Mānoa General Education Requirement. Some of these courses are considered prerequisite to some courses in the major.

## Major Requirements (Specialization in Landscape Horticulture)

The following courses need to be taken for this specialization:

- TPSS 354
- TPSS 463
- TPSS 481
- PEPS 363/363L
- PEPS 405

## Electives

The student must take 15 credits from a list of over 20 courses. The options available are listed on the Bachelor Degree Program Sheet, [www.manoa.hawaii.edu/ovcaa/programsheets/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

## Specialization in Plant Physiology and Genetics

Specializing in plant physiology and genetics allows students to cross the traditional boundaries that have separated genetics, plant physiology, molecular biology, and their application to crop production. By linking laboratory approaches and plant production systems through the application of plant biotechnology students learn to solve multi-disciplinary problems. Students can select courses that allow concentration on genetic engineering or whole plant physiology and plant breeding to address real-world problems.

Students selecting this option must take MATH 140 or NREM 203, BIOL 171/171L, BIOL 172/172L, and CHEM 161/161L, 162/162L and TPSS 492/492L. Some of these courses will fulfill part of the Natural Science requirement of the UH Mānoa General Education Requirement. Some of these courses are considered prerequisite to some courses in the major.

## Major Courses (Specialization in Plant Physiology and Genetics)

Students are required to take 10 courses (30 credits) from a list of over 30 choices. The available options are listed on the Bachelor Degree Program Sheet. For information on a Bachelor Degree Program Sheet, [www.manoa.hawaii.edu/ovcaa/programsheets/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

## Electives

Students may choose from the array of courses, offered on an advising list of courses to fulfill the university credit requirement for graduation. Advisors will be available to assist students in selecting courses that prepare students for a career in plant sciences and genetics.

## Specialization in Plant Production and Management

Students are prepared to produce, manage, and market plants grown as crops or in landscapes with an emphasis on sustainable productivity with appropriate pest and disease management. Students learn to solve horticultural problems using evidence-based methods.

Students selecting this option need to take MATH 140 or NREM 203, BIOL 171/171L, BIOL 172/172L, and CHEM 161/161L and 162/162L and TPSS 492/492L. 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 (Specialization in Plant Production and Management)

The following courses are required for this specialization:

- TPSS 364
- TPSS 420
- TPSS/PEPS 481
- PEPS 363



- PEPS 363L
- PEPS 405

In addition, the student must take 6 courses from a list of over 30 choices. The options available are listed on the Bachelor Degree Program Sheet, [www.manoa.hawaii.edu/ovcaa/programsheets/](http://www.manoa.hawaii.edu/ovcaa/programsheets/).

### Elective Courses

Students may choose from the array of courses offered on an advising list of courses to fulfill the university credit requirement for graduation. Advisors will be available to assist students in selecting courses that prepare students for a career in horticultural crop production and management.

### 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 or BUS 312
- TPSS 341
- TPSS 351
- TPSS 429

### Academic Minor in Plant Production and Management

A minimum of 15 credits of 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: [leonhardt@hawaii.edu](mailto:leonhardt@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. Minimum CBT TOEFL scores are 600/100 (paper/internet), with subset scores of 25 for listening and 25 for speaking are 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.

### **MS Degree, Plan A (thesis) and B (without thesis)**

The intended study of the MS Plan A program is to further a student's graduate studies leading to the PhD degree or successful entry to careers as researchers and technicians. Graduates of the MS Plan B program typically enter careers in education, agribusiness, extension service, and other agricultural related occupations.

#### **Requirements**

**MS Plan A:** Students must complete a minimum of 24 credits hours of course work and 6 credit hours of thesis preparation. A final oral examination is also required.

**MS Plan B:** Students must complete a minimum of 30 credits as follows: at least 6 credits in TPSS 600+; 6 credits in TPSS/CTAHR/Botany 600+ (see graduate chair for list of allowed courses), 6 credits in other 600+; 6 credits of 699; 6 credits in other 400/600 level classes

**Proposal defense:** MS Plan A students are required to give a thesis proposal seminar, preferably in the second semester.

**Seminar:** All students must take TPSS 654 (Communications in the Sciences) during their graduate study and register for TPSS 667 (Graduate Seminar) once every academic year in which they are registered as full-time student or equivalent. An exception can be made during the final semester, in which the dissertation defense or Plan B project report is given in place of TPSS 667.

**Lecture Requirement:** All MS students are required to give one lecture in a TPSS course during their program. The student will be evaluated by the faculty teaching the course, and this evaluation will be added to the student's file.

**MS-Thesis Plan A:** See graduate chair on thesis preparation. Upon development of a thesis proposal in conjunction with your advisor and the selection of graduate committee, the student will advanced to candidacy. The thesis topic must be submitted and approved by your graduate committee prior to mid-term of the semester after you have been advanced to candidacy. You may register for TPSS 700 only after your thesis topic has been approved by your committee.

**Final Examination-MS Plan A:** A final oral examination on course of study and project is required. The first part of the examination consists of a seminar presentation and defense of the research, which is open to the public and is one hour in length. Following the presentation, student will be examined in detailed on the conduct and results of the thesis by the committee.

**Final Examination-MS Plan B:** A final oral examination is required. The examination consists of a seminar presentation which is open to the public and is one hour in length. The seminar will be presented on a topic agreed upon by the student

and their advisor/committee chair. Topics presented included the research conducted under the advisor's direction in TPSS 699.

### **MS Degree Plan C**

Graduate Division and TPSS in CTAHR allow for a Plan C Masters degree. See the graduate chair for more information.

### **Doctor of Philosophy Degree**

PhD graduates are expected to enter careers as researchers and/or educators in institutions of higher learning, both 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**

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. Course requirements are established by the student's graduate committee.

**Proposal defense:** PhD students are required to give a dissertation proposal seminar within the first year of their program.

**Seminar:** Candidates must register for TPSS 667 (Graduate Seminar) once every academic year in which they are registered as full-time or equivalent. An exception is made in the final semester in which the dissertation defense can be substituted for seminar. All students must take TPSS 654 (Communications in the Sciences) or its equivalent during their first year as a substitute for one semester of TPSS 667.

**Lecture Requirement:** All PhD students are required to give three lectures in TPSS courses during the course of their program. The student will be evaluated by the faculty member teaching the course, and this evaluation will be added to the student's file.

**Comprehensive Examination:** An oral or oral and written comprehensive examination is conducted by your graduate committee for all PhD candidates. This examination may cover any subject thought pertinent by your committee members. The comprehensive examination may be repeated once at the option of your committee. If the student fails to pass the exam the second time, the student will be dropped from the program.

**Dissertation:** 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. For further information, see the graduate chair. The dissertation proposal must be submitted and approved by your graduate committee during the semester following completion of the qualifying examination. You may register for TPSS 800 (Dissertation Research) only after approval of your dissertation proposal.

**Final examination:** A final oral examination on student's dissertation is required. The first part of the examination consists of a seminar presentation and defense of your research, which is open to the public and is one hour in length. Following the open seminar presentation, there will be more thorough examination of the research and results of the dissertation by the members of your committee and any other members of the graduate faculty who wish to attend.