

# College of Tropical Agriculture and Human Resources



## Administration

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Dean: Andrew G. Hashimoto  
 Associate Dean: Marlene M. Hapai

## General Information

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

### Contents

General Information .....	309
Advising .....	310
Undergraduate Programs .....	310
Graduate Programs .....	311
Instructional and Research Facilities .....	311
Student Organizations .....	311
Honors and Awards .....	312
Family and Consumer Sciences .....	312
Human Nutrition, Food, and Animal Sciences .....	314
Molecular Biosciences and Bioengineering .....	318
Natural Resources and Environmental Management .....	321
Plant and Environmental Biotechnology Program .....	326
Plant and Environmental Protection Sciences .....	328
Tropical Plant and Soil Sciences .....	332

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, the strengthening of families, and the improvement of communities.

Through its research activities, the college promotes the advancement of agricultural 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; bioengineering; bioremediation; biochemistry; human and animal nutrition; breeding and genetics; and culture, production, economics, marketing, and quality of life for individuals and families.

## Degrees and Certificates Offered

**Certificates:** Graduate Resource Management Certificate

**Bachelor's Degrees:** BS in natural resources and environmental management, BS in tropical plant and soil sciences, BS in animal sciences, BS in bioengineering, BS in plant and environmental protection sciences, BS in family resources, BS in apparel product design and merchandising, BS in food science and human nutrition, BS in plant and environmental biotechnology

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

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

## Advising

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

## Undergraduate Programs

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

### Admission Requirements

Students may enter CTAHR as freshmen or as transfer students from other departments or academic institutions. Requirements for admission are the same as those for the UH Mānoa campus in general, except for the food science and human nutrition, family resources, and apparel product design and merchandising majors. Transfer students are required to have a minimum GPA of 2.5 for apparel product design and merchandizing and natural resources and environmental management majors, 2.6 for family resources majors, and 2.8 for food science and human nutrition majors. Additional course requirements may also apply to these 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 at least 60 credit hours of non-introductory courses (i.e., those numbered 300 and above or having a college-level prerequisite) and maintain a minimum cumulative GPA of 2.0 in a minimum of 126-128 credit hours as prescribed by the major. Some majors may require more credit hours. All CTAHR undergraduates are required to complete a set of interrelated courses: SP 151 Personal and Public Speech or equivalent; FAMR 380/380L Research Methodology/Lab or AREC 310/NREM 310 Statistics in Agriculture and Human Resources; and an internship or senior design course within their major field. Foreign language requirements are specific to each

academic program. Check with the departmental adviser for more information.

### Double Major or Second Degree

Students seeking a double major must have a minimum cumulative GPA of 3.0, demonstrate that the proposed majors are substantially different, and obtain approval from undergraduate advisers in both of the relevant departments.

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

### Related Undergraduate Programs

#### Veterinary Science

Students interested in becoming veterinarians generally major in Animal Sciences, within the Department of Human Nutrition, Food and Animal Sciences, and participate in CTAHR's pre-veterinary curriculum. A BS degree is desirable but not required for veterinary schools. The CTAHR pre-veterinary adviser assists students in meeting the admission requirements of veterinary schools that participate in the Western Interstate Commission for Higher Education (WICHE) program, including the University of California—Davis, Colorado State University, and the Washington, Oregon, Idaho College of Veterinary Medicine at Washington State University. Hawai'i students are also encouraged to make applications to other continental United States veterinary schools that accept nonresident students. Students should contact the Web site of the Association of American Veterinary Medical Colleges for information about the Veterinary Medical College Application Service at [www.aavmc.org/vmcas/vmcas.htm](http://www.aavmc.org/vmcas/vmcas.htm) and for more information about specific requirements for admission to veterinary schools. The department also sponsors the Pre-Veterinary Club of Hawai'i, which offers students opportunity to interact with other students interested in veterinary medicine and working with animals. Students seeking additional information and advising should contact the Department of Human Nutrition, Food and Animal Sciences (Agricultural Sciences Building, 1955 East-West Road, Room 216, Honolulu, Hawai'i 96822 (808) 956-8236).

#### Agriculture Education

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

## Home Economics Education

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

## Graduate Programs

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

Three of CTAHR's graduate programs in tropical agriculture (tropical plant and soil sciences, entomology, and natural resources and environmental resources) 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 University 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 the University of Hawai'i. 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 agricultural sciences. On-campus affiliations with the Hawai'i Institute of Marine Biology, Water Resources Research Center, East-West Center, Harold L. Lyon Arboretum, Sea Grant College Program, and Hawai'i Natural Energy Institute extend CTAHR's resources. The college is also affiliated closely with off-campus institutions, such as the Bernice P. Bishop Museum, USDA/ARS Tropical Fruit and Vegetable Research Laboratory, Hawai'i Agriculture Research Center, U.S. Geological Survey, National Marine Fisheries Service, and Hawai'i Department of Agriculture.

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

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

## Admission Requirements

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

## College Requirements

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

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

## Instructional and Research Facilities

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

## Student Organizations

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

- Innovators of Fashion
- Pre-Veterinary Club
- Food Science and Human Nutrition Council
- Tropical Plant and Soil Science Society
- Friends of the Family
- Student Ambassadors
- Agronomy and Soil Science Graduate Student Organization
- Agricultural and Resource Economics Graduate Student Organization
- Ka Mea Kolo (Entomology Club)
- Plant Pathology Graduate Student Organization
- Bioengineering Club
- Horticulture 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 211, (808) 956-8183.

# Family and Consumer Sciences

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

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

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

## Faculty

- L. L. Arthur, PhD—history of costumes, social-psychological aspects of dress
- R. A. Caulfield, PhD—infancy, childhood, human development
- D. R. Ching, PhD—agricultural leadership
- D. L. F. Chung, MEd—fashion design
- D. H. Davidson, PhD—cross-cultural child rearing, life span development
- B. De Baryshe, PhD—parenting, family resilience
- C. A. Dickson, PhD—fashion merchandising, international textile products markets
- J. W. Engel, PhD—family relationships, marriage development
- G. F. Fong, EdD—family resource management
- A. M. Fontes, MS—leadership and personal development
- C. S. Ikeda, MEd—technology and education
- L. J. Kawamura, MPh—4-H youth development, foods and nutrition
- P. Kutara, MS—consumer economics
- M. I. Martini, PhD—parenting and family relationships across cultures
- D. M. Masuo, PhD—consumer and family economics
- M. A. Morgado, MA—fashion merchandising, fashion and culture
- C. M. Nakatsuka, MEd—community service learning, 4-H
- R. W. Saito, MS—4-H youth development
- M. K. K. L. Spotkaeff, MS—youth education and coordination

- R. W. Wall, PhD—family financial planning
- R. M. Yoshino, MA—community services
- J. S. M. Young, MA—leadership and volunteer development
- S. Yuen, PhD—human and family development
- H. H. Zeug, PhD—human development, family life

**Degrees Offered:** BS in apparel product design and merchandising (textiles and clothing), BS in family resources

## The Academic Program

The Department of Family and Consumer Sciences has been an integral part of the land-grant system and of the University of Hawai'i since 1907. The department offers two bachelor of science degree programs: apparel product design and merchandising (APDM) and family resources (FAMR).

The APDM program integrates theoretical and applied knowledge regarding apparel design, consumer textiles, historic costume, and apparel production with 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. Positions include 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 may specialize in apparel design, apparel merchandising, or fashion promotion, or they may develop individualized programs in consultation with an adviser.

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

In addition to courses offered in the department, there are opportunities for leadership experience and friendship through professional and honorary organizations. *Phi Upsilon Omicron* is a national honorary society in family and consumer sciences with members invited from both programs. *Friends of the Family* provides service and professional experiences for FAMR majors while *Innovators of Fashion* does the same for APDM majors. Majors from any discipline are welcome in the latter organizations.

## Undergraduate Study

### Advising

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

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

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

### Apparel Product Design and Merchandising Program

Apparel Product Design and Merchandising (APDM) is a comprehensive undergraduate program whose mission is to prepare students with appropriate knowledge and skills for career positions in apparel and fashion-related industries. Classroom work is enhanced by the largest costume collection at a university in the United State giving students and faculty a rich source of items to draw upon for their classes and projects. New storage facilities and computerization make access simple. In addition, students have the opportunity to learn and use skills such as desktop publishing and presentation graphics to produce materials and presentations. Many classes use web-based technologies to supplement classroom activities. Access to modern computer labs within the college make learning to do fashion illustration fun and challenging and advanced computer systems and equipment also provide modern skills for apparel design majors. 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 its related areas is provided.

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

- an understanding of and appreciation for the impact of global production and distribution of apparel.
- the ability to plan, develop, and merchandise apparel product lines and to evaluate the quality of the products being developed.
- 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.

### Career Focus Areas

In addition to taking a core of university and APDM courses, students each work with an adviser to develop an in-depth program of study that will provide the basis for a future career in apparel.

**Apparel Design.** The apparel design focus prepares students for careers in the apparel industry as designers, assistant designers, fashion stylists, and manufacturers. Students have a unique opportunity to study the theoretical and applied aspects of apparel design and costume history in a multicultural environment enhanced by a major costume collection; computerized fashion illustration software; and computerized grading, marker-making, and pattern-making systems.

**Apparel Merchandising.** The apparel merchandising focus offers a unique combination of fashion theory, marketing, and product information relative to retail and wholesale operations. Graduates are prepared for apparel management careers as buyers, merchandise managers, sales representatives, and fashion coordinators for the local, national, and international markets.

**Fashion Promotion.** In the fashion promotion focus, students take courses in communication, writing and reporting, and advertising to supplement APDM courses. The curriculum is designed to equip students with an understanding of the use of communications media for promoting sales of apparel and related products and services. Graduates are working in mall management, advertising, and visual merchandising.

**Individualized Programs.** In addition to the types of programs described above, majors may work with an adviser to develop a curriculum focus of their own choosing. Examples of such programs include historic costume, theater costume, fiber/apparel arts, and a combination of design and merchandising.

### Entrance Requirements

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

### Degree Requirements

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

### Family Resources Program

The family resources program provides students with a comprehensive education in family development and resource management, including course work and study in the areas of family relations and marriage development, 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. The FAMR curriculum provides 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. An internship in the student's area of focus is an integral part of the curriculum.

### Entrance Requirements

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

### Degree Requirements

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

## Human Nutrition, Food, and Animal Sciences

Agricultural Sciences 216

1955 East-West Rd.

Honolulu, HI 96822

Tel: (808) 956-7095

Fax: (808) 956-4024

E-mail: [hnfas@ctahr.hawaii.edu](mailto:hnfas@ctahr.hawaii.edu)

Web: [www.ctahr.hawaii.edu/ctahr2001/CTAHCatalog/hnfas.html](http://www.ctahr.hawaii.edu/ctahr2001/CTAHCatalog/hnfas.html)

### Faculty

- D. L. Vincent, PhD (Chair)—reproductive physiology and endocrinology
- A. C. Brown, PhD, RD—medical nutrition therapy, complementary medicine, herbs
- B. A. Buckley, PhD—beef production and breeding
- J. R. Carpenter, PhD—ruminant nutrition and metabolism, forage evaluation, and ruminant production
- L. Y. T. Ching, BS—livestock extension education (Kaua'i Cooperative Extension Service)
- D. A. Dooley, PhD—diet and behavior, nutrition education
- M. A. Dunn, PhD—nutritional biochemistry, vitamins and minerals
- M. W. DuPonte, MS—livestock extension education (Hawai'i Cooperative Extension Service)

- G. K. Fukumoto, MS—livestock extension education (Hawai'i Cooperative Extension Service)
- A. S. Huang, PhD—food chemistry
- W. T. Iwaoka, PhD—food chemistry, food safety, food science education
- N. A. Kanehiro, MS, RD—human nutrition extension education (O'ahu Cooperative Extension Service)
- Y. S. Kim, PhD—meat science, muscle biology, animal growth
- C. N. Lee, PhD—dairy production and reproductive management
- S. R. Malecha, PhD—aquaculture production and breeding
- S. T. Nakamoto, MBA, PhD—marketing of perishable products, agricultural economics
- L. C. Nakamura-Tengan, MS—consumer food safety, extension education and resource management (Maui Cooperative Extension Service)
- R. Novotny, PhD, RD—community and international nutrition
- J. S. Powley, MS—livestock extension education (Maui Cooperative Extension Service)
- A. C. Shovic, PhD, RD—dietetics
- C. A. Titchenal, PhD—sports nutrition, energy balance
- C. W. Weems, PhD—molecular endocrinology and reproduction
- H. M. Zaleski, PhD—swine production and management, reproductive physiology
- J. M. Zee, MPH, RD—human nutrition extension education (Hawai'i Cooperative Extension Service)

### Graduate Faculty in Animal Sciences

- J. R. Carpenter, PhD (Chair, graduate field of study)—ruminant nutrition, feed and forage evaluation, beef and dairy production
- B. A. Buckley, PhD—beef production and genetics
- Y. S. Kim, PhD—meat science, muscle biology, animal growth
- C. N. Lee, PhD—dairy production and reproductive management
- S. R. Malecha, PhD—aquaculture production and breeding, pond management
- D. L. Vincent, PhD—animal physiology, reproduction and endocrinology
- C. W. Weems, PhD—molecular endocrinology and reproduction
- H. Zaleski, PhD—swine production and management, reproductive physiology

### Cooperating Graduate Faculty in Animal Sciences

- S. Atkinson, PhD—endocrinology and reproduction of marine mammals
- E. G. Grau, PhD—fish endocrinology
- Y. S. Weems, PhD—reproductive endocrinology

### Affiliate Graduate Faculty in Animal Sciences

- B. Argue, PhD—aquacultural genetics
- J. A. Brock, DVM, MS—aquatic diseases
- O. Decamp, PhD—aquaculture microbiology
- J. Dobbs, PhD—domestic animals, avian and wildlife nutrition
- I. Foster, PhD—aquaculture feeds and nutrition
- C. Laidley, PhD—aquaculture reproductive endocrinology
- S. Moss, PhD—aquaculture production and shrimp program
- B. Okimoto, DVM—exotic animal husbandry and diseases
- T. Ostrowski, PhD—aquaculture feeds and nutrition
- A. Tacon, PhD—aquaculture feeds and nutrition

**Graduate Faculty in Food Sciences**

- C. G. Cavaletto, MS (Chair, graduate field of study)—sensory evaluation and food processing  
 H. Ako, PhD—nutritional biochemistry, aquaculture, lipid metabolism  
 A. M. Alvarez, PhD—bacterial disease  
 D. Borthakur, PhD—microbiology, biotechnology  
 B. Buckley, PhD—beef production and breeding  
 D. A. Dooley, PhD—diet and behavior, nutrition education  
 L. Gautz, PhD—instrumental quality evaluation  
 A. S. Hodgson, PhD—food technology extension, food safety and quality  
 A. S. Huang, PhD—food chemistry  
 W. T. Iwaoka, PhD—food chemistry, food safety, food science education  
 Y. S. Kim, PhD—meat science, muscle biology, animal growth  
 Q. Li, PhD—analytical methodology to identify environmental toxins  
 J. H. Moy, PhD—food engineering, food irradiation, processing and technology  
 W. K. Nip, PhD—handling and processing of seafood, tropical fruits and root crops  
 R. Paull, PhD—fresh fruit and vegetable physiology and handling  
 W. W. Su, PhD—bioprocess engineering  
 C. S. Tang, PhD—biochemistry of natural products

**Cooperating Graduate Faculty in Food Sciences**

- R. S. Fujioka, PhD—water resources, food microbiology  
 S. Kathariou, PhD—food microbiology  
 P. Q. Patek, PhD—microbiology  
 J. Seifert, PhD—toxicology  
 C. S. Tamaru, PhD—live feed, aquaculture

**Affiliate Graduate Faculty in Food Sciences**

- A. Tacon, PhD—aquaculture feeds and nutrition

**Graduate Faculty in Nutritional Sciences**

- M. A. Dunn, PhD (Chair, graduate field of study)—nutritional biochemistry, vitamins and minerals  
 A. C. Brown, PhD, RD—medical nutrition therapy, complementary medicine, herbs  
 J. R. Carpenter, PhD—protein and fiber utilization  
 D. A. Dooley, PhD—diet and behavior, nutrition education  
 A. S. Huang, PhD—food chemistry  
 W. T. Iwaoka, PhD—food chemistry, food safety  
 R. Novotny, PhD, RD—community and international nutrition  
 A. C. Shovic, PhD, RD—dietetics  
 C. A. Titchenal, PhD—sports nutrition, nutritional biochemistry, energy balance  
 C. W. Weems, PhD—reproductive endocrinology, steroids

**Cooperating Graduate Faculty in Nutritional Sciences**

- A. Franke, PhD—analytical chemistry, phytochemicals  
 K. Glanz, PhD—nutrition behavior, workplace wellness  
 R. Hetzler, PhD—exercise physiology, sports nutrition

- D. A. Lally, PhD—exercise physiology  
 L. Le Marchand, MD, MPH, PhD—nutritional epidemiology  
 G. Maskarinec, MD, MPH—diet and cancer  
 C. Waslien, PhD, RD—international nutrition, geriatrics

**Affiliate Graduate Faculty in Nutritional Sciences**

- D. Galanis, PhD—Pacific island nutrition  
 W. D. B. Hiller, MD—sports nutrition  
 S. J. Taussig, PhD—industrial enzymology  
 T. Vogt, MD—dietary intervention trials

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

**The Academic Program**

Animal science (ANSC) is the application of experimental investigation, technology, and other scientific principles for the advancement of efficient and environmentally friendly animal agriculture. The present program centers on swine, sheep, beef and dairy cattle production and pond aquaculture production systems. Students receive training in both basic and agricultural sciences, as well as in animal sciences. Unlike most continental United States institutions, the emphasis of the present program is on tropical production systems with particular reference to the Pacific Basin area. Animal scientists have careers in management and production, food processing and marketing, veterinary sciences, the pharmaceutical and feed industries, teaching, extension education, and research. Those positions require skills in disciplines such as management, nutrition, genetics, physiology, meat science, animal health, feed and forage utilization, engineering, business marketing and salesmanship.

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 curricula options are prepared for diverse careers in the food industry, health-care and fitness facilities, hospitals, nutrition education and communication enterprises, extension education in nutrition, government or private-sector food and nutrition agencies, science related research laboratories, and science education.

The curricula in food science and human nutrition (FSHN) have a strong science base that is applied to food and human nutrition. Students learn problem-solving skills, approaches to critical thinking and basic principles in two related disciplines. Options in the curricula include dietetics, human nutrition, and science education. The dietetic option has been approved by the American Dietetic Association (Plan V). The human nutrition option can be directed toward nutrition education, sports nutrition, or other interests. The human nutrition option can serve as a pre-professional program in medicine, dentistry, nutrition, or other scientific graduate programs.

Students are strongly encouraged to take chemistry and biological sciences courses prior to entering the program.

Transfer students in FSHN are required to have a GPA of 2.8 or greater and to have taken FSHN 185 with a “B” or better and CHEM 161/161L with a “C” or better.

Upon entering either program, Animal Sciences (ANSC) or Food Science and Human Nutrition (FSHN), students will be assisted by academic advisers to identify their career objectives and select an appropriate option for study.

### **Advising**

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

## **Undergraduate Study**

### **BS in Animal Sciences**

#### **Requirements**

- Course work in the basic sciences, mathematics, economics, and animal sciences including the following:
  - NREM 220 or ECON 131
  - CHEM 161/161L, 162/162L, and 272/272L
  - MBBE 402/402L
  - MATH 140 or above
  - PHYS 151/151L
  - One of BIOL 171, MICRO 130, SCI 124, or ZOOL 101
- Animal sciences required courses:
  - ANSC 200, 201, 244, 301, 321, and 445
  - Three of the following: ANSC 451, 453, 454/454L, 462, and 472
  - One of the following production courses: ANSC 431, 432, 433, and 450
- Additional electives to make a total of 128 credit hours

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 adviser, 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.

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

Complete descriptions of course requirements for each option are available from the department.

#### **Requirements**

A total of at least 128 credits are required for graduation.

## **Graduate Study**

The graduate program in Human Nutrition, Food and Animal Sciences offers three MS degree programs, one in animal sciences, one in nutritional sciences, and one in food science. The MS in food science is an interdisciplinary / interdepartmental graduate program. Admission and degree requirements differ among the three graduate programs. All programs offer Plan A (thesis) and Plan B (non-thesis options).

### **MS in Animal Sciences**

The MS in animal sciences is offered in the areas of genetics, nutrition, animal diseases, and physiology. Specialty areas consist of beef-cattle nutrition 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; muscle biology and meat science; health and disease; and fresh water prawn and marine shrimp breeding, nutrition and pond management systems. Emphasis is on tropical animal science, aquaculture pond management; yield trials and animal management systems. Candidates wishing to specialize in nutrition, animal diseases, meat science, muscle biology, reproduction or physiology should be strong in chemistry and biochemistry with a good background in mathematics. 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, (2) provide evidence of superior scholarship in previous academic work, (3) arrange for three letters of recommendation, (4) submit GRE general and subject matter (biology) scores, and (5) obtain admission clearance by the Graduate Division. An application 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.

### **Degree Requirements**

#### **Plan A**

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

- At least 12 credits of course work numbered 600 and above, including two credits of ANSC 641 (seminar) and excluding 699 and thesis 700.
- A maximum of 3 credits of directed research (ANSC 699).
- 9 credits of thesis research in ANSC 700 with at least 1 credit taken in the final semester.
- Remaining credits must be in courses numbered 400 and above.

**Plan B**

Student must complete a minimum of 32 credit hours, including:

- At least 18 credits in course work numbered 600 and above, including ANSC 641 and excluding 699.
- 4 credits of directed research (ANSC 699).
- Remaining credits must be in course numbers 400 and above.

Candidates must be enrolled during the term in which the degree is granted; regular course work or ANSC 500 Master's Plan B studies may be used to meet this requirement. ANSC 500 is offered as a 1 credit course a mandatory grading of S/NG but does not count toward meeting degree requirements.

**Both Plan A and B**

- Students are required to attend weekly seminars and to present an animal sciences seminar each semester. Attendance is mandatory unless legitimate reason is given for being absent. 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, 687 and a graduate-level statistics course.

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 as well as in the other disciplinary graduate programs in CTAHR or other related disciplines such as anatomy and reproductive biology, biochemistry, chemistry, genetics, microbiology, physiology, public health, zoology. Because of the diversity of specialization within animal sciences, specific course requirements will vary considerably among students.

A general examination is required.

**MS in Nutritional Sciences**

The Graduate Program in nutritional sciences offers a master's degree that prepares students to understand the scientific basis of nutrition, its application to health and fitness, and to develop skills in both basic and applied research methods. Subject areas of concentration include nutritional biochemistry, nutritional epidemiology, diet and cancer, mineral nutrition and toxicology, sports nutrition, nutrition education, nutritional product development, and community and international nutrition. Cooperating programs include Public Health, Kinesiology and Leisure Science, Food Science, Animal Science, Physiology, and the Cancer Research Center of Hawai'i.

Depending on the area of focus, students are prepared for diverse careers in food and nutrition 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 nutrition research scientists in the health-

care industry or government and academic institutions. Many have pursued further graduate study at major universities around the country.

**Admission Requirements**

Academic prerequisites include a Bachelor's degree in nutrition or a closely related field with a minimum grade point average of 3.0 and undergraduate course work in nutrition, human physiology, biochemistry, and statistics. Motivated students without a nutrition-related degree are encouraged to apply, but will be expected to make up undergraduate course deficiencies. Students are strongly encouraged to take chemistry and biological science courses prior to applying to the program. Additional requirements include submission of GRE General Test scores, two confidential recommendations (using our program's recommendation forms), a TOEFL score of 600 or above if a foreign student, and a completed Graduate Admissions Application. The deadline for receipt of all application materials are February 1 for Fall semester applicants, and September 1 for Spring 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 adviser. Both options require passing an oral exam of basic nutrition knowledge to advance to candidacy for the MS degree, and a final examination based on the thesis (Plan A) or Directed Reading and Research (Plan B).

**Plan A (Thesis)**

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

- 6-9 credits of Directed Reading and Research.
- 18 credit hours of coursework at the graduate level, 12 of which must be at the 600 level.
- The remaining credits are from electives.

**Plan B**

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

- 6-9 credits of Directed Reading and Research.
- 18 credit hours of coursework at the graduate level, 12 of which must be at the 600 level.
- Remaining credits are fulfilled by electives that are selected in consultation with the graduate adviser.

A complete description of degree requirements and coursework can be obtained by contacting the department office.

**Interdisciplinary/Interdepartmental MS in Food Science**

The Department offers an interdisciplinary/interdepartmental MS in food science. The areas of concentration are food

safety and quality, food processing and engineering, food chemistry and biochemistry, food biotechnology and special area. 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

To be considered for admission to the interdisciplinary / interdepartmental MS program in Food Science, an applicant must (1) hold a bachelor's degree (BA or BS) from an accredited institution of higher learning, (2) have taken one course each in organic chemistry, microbiology, biological science (in addition to microbiology) college physics, and biochemistry, (3) arrange for two confidential academic or professional letters of recommendation, (4) submit GRE scores, and (5) obtain admission clearance by the Graduate Division. Foreign students must obtain TOEFL scores of 570 or above. Admission may be possible with prerequisites, in which case the student must complete deficiencies in the first year.

### Degree Requirements

#### Plan A

Student must complete a minimum of 32 credit hours, including:

- At least 18 credit hours of course work, at least 12 credits numbered 600 – 798, excluding credits in 699 courses, Directed Research and 700 courses, Thesis Research.
- 12 credits of thesis research in 700 Thesis Research with at least 1 credit taken in the final semester.
- One (1) credit in a Departmental Seminar such as FSHN 681.
- One (1) credit in FSHN 701 Topics in Food Science.

#### Plan B

Students must complete a minimum of 29 credit hours, including:

- At least 21 credit hours of course work must be in courses numbered 600 – 798, excluding 700 Thesis Research.
- 6 to 9 credits of 699 Directed Research courses.
- One (1) credit in a Departmental Seminar such as FSHN 681.
- One (1) credit in FSHN 701 Topics in Food Science.

Complete description of course and other requirements are available from the department.

### Honors and Awards

The department has several scholarships that are awarded to deserving students.

## Molecular Biosciences and Bioengineering

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Web: [www.ctahr.hawaii.edu/ctahr2001/CTAHRCatalog/mbbe.html](http://www.ctahr.hawaii.edu/ctahr2001/CTAHRCatalog/mbbe.html)

### Faculty

- \*C. M. Kinoshita, PhD (Chair)—process engineering, bioremediation
- \*D. Borthakur, PhD (Graduate Chair, Molecular Biosciences and Bioengineering)—plant-microbe interaction, plant biotechnology
- \*P-Y. Yang, PhD (Graduate Chair, Bioengineering)—bioenvironmental engineering
- \*H. Ako, PhD—aquaculture, environmental biochemistry and biotechnology
- \*D. A. Christopher, PhD—photosynthesis, photosensory signal transduction, gene regulation, genomics
- \*L. D. Gautz, PhD—bioproduction control and automation, electromechanical systems engineering
- \*A. G. Hashimoto, PhD—bioengineering
- \*M. Kumagai, PhD—gene isolation and expression in bacteria, yeast, and plants
- \*P. S. Leung, PhD—bioproduction systems analysis, quantitative methods, resource economics
- \*Q. Li, PhD—bioremediation, environmental biotechnology
- \*J. H. Moy, PhD—bioprocess engineering, radiation biology
- \*W. W. Su, PhD—biochemical engineering, cell-culture engineering
- \*C-S. Tang, PhD—biochemistry of natural products, bioremediation
- \*S. Q. Turn, PhD—biological process engineering, bioremediation
- \*J-K. Wang, PhD—bioproduction systems engineering, aquacultural engineering
- \*H. Y. Yamamoto, PhD—plant biochemistry, photosynthesis

### Cooperating Graduate Faculty

- A. Alvarez, PhD—plant-pathogen interactions, biocontrol of plant diseases
- M. J. Antal, PhD—alternate energy, combustion
- S. Chang, PhD—vaccine development, molecular immunology
- E. D. H. Cheng, PhD—hydrology, hydraulics
- M. Cooney, PhD—marine biotechnology
- H. G. de Couet, PhD—molecular biology, invertebrate biology, biotechnology
- M. Dunn, PhD—molecular nutrition
- J. Hu, PhD—plant virology
- Y. S. Kim, PhD—animal biotechnology
- J. Leong, PhD—marine biotechnology

\* Graduate Faculty

C. C. K. Liu, PhD—hydrology, environmental systems engineering  
 S. Malecha, PhD—shrimp biology and biotechnology  
 S. M. Masutani, PhD—thermochemical conversion of biomass, sequestration of carbon dioxide  
 W. C. McClatchey, PhD—molecular evolution, conservation biology  
 G. Mocz, PhD—molecular instrumentation, proteomics  
 C. Morden, PhD—molecular systems  
 P. Nerurkar, PhD—medical biochemistry  
 C. Ray, PhD—groundwater hydrology, bioremediation  
 P. Sun, PhD—molecular biology, shrimp biotechnology  
 A. Theriault, PhD—medical technology, signal transduction  
 M. C. M. Tsang, PhD—materials handling, processing engineering  
 J. Yu, PhD—bioengineering, marine bioproduct development

### Affiliate Graduate Faculty

R. P. Adams, PhD—molecular biodiversity  
 H. Albert, PhD—plant molecular biology and biotechnology  
 J. Berestecky, PhD—microbial genetics, biotechnology  
 S. Divakaran, PhD—marine bioproducts  
 M. M. Fitch, PhD—micropropagation and genetic transformation of papaya  
 J. K. Ladha, PhD—nitrogen fixation, soil nutrition, biofertilizer  
 C-S Lee, PhD—aquaculture  
 R. Ming, PhD—sugarcane breeding and biotechnology  
 S. Moss, PhD—aquaculture  
 P. H. Moore, PhD—sugar cane physiology  
 L. G. Obaldo, PhD—aquacultural engineering  
 G. S. D. Pruder, PhD—aquacultural engineering  
 A. Wiczorek, PhD—population biology  
 J. Zhu, PhD—plant transformation, biotechnology

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

### The Academic Program

The Molecular Biosciences and Bioengineering Department features a multidisciplinary faculty having a broad spectrum of interests in biotechnology, molecular biology, biochemistry, and bioengineering. 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 bioengineering (BS and MS) and in molecular biosciences and bioengineering (MS and PhD).

### Bioengineering Program

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

## Undergraduate Study

### BS in Bioengineering

The first part of the undergraduate bioengineering curriculum is similar to other engineering fields, e.g., calculus, physics, chemistry, and computer programming. Students in Bioengineering take additional courses in biological sciences such as biology, organic chemistry, and biochemistry. During the latter part of the program, students take basic engineering courses such as mechanics and thermodynamics as well as bioengineering courses with emphasis giving to solving practice engineering problems involving biological systems. The mission of the bioengineering program is to provide students a unique opportunity to study the fundamentals of engineering and biology and the application of engineering to biological systems. To fulfill this mission the BE program:

1. Provides students with the fundamentals of engineering,
2. Trains students to become engineers with the skills to design, manufacture, test, and/or operate systems in which living organisms or biological products are a significant component, and
3. Graduates students with the skills to function in modern society as expected of a professional engineer with a baccalaureate degree.

The undergraduate program is accredited by ABET.

### Requirements

- General Education Core requirements, including the following:
  - SP 251
  - ECON 120 or ECON 130
  - BIOL 171/171L
  - CHEM 171/171L and 272/272L
  - ENG 100
  - HIST 151 and 152
  - Humanities (one course)
  - MATH 241, 242, 243, and 244
  - PHYS 170/170L and 272/272L
  - Social Science (one course)
  - A course with focus on Ethics
  - A course with focus on Hawaiian, Asian, or Pacific issues
- College requirements:
  - NREM 310
- Basic engineering requirements:
  - EE 160 and 211
  - CEE 270, 271, and 320
  - ME 311
  - Engineering mathematics elective
- Bioengineering requirements:
  - BIOL 172/172L or MICRO 351/351L and a biology elective
  - BE 351/351L, 360, 401, 413, 437, 460, 481, and 482
  - At least two courses from BE 411, 431, 436, or 440

A minimum of 128 credit hours is required for graduation.

## Graduate Study

### MS in Bioengineering

The research areas in bioengineering 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.

### Contact Information

Dr. P. Y. Yang  
 Graduate Chair Bioengineering  
 University of Hawaii  
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### Molecular Biosciences and Bioengineering Graduate Program

The Molecular Biosciences and Bioengineering (MBBE) graduate program offers both MS and PhD degrees. The MBBE research and graduate training center around understanding the biochemical, nutritional, and molecular-biological processes that underlie growth, development, photosynthesis, and stress, especially as related to tropical agriculture, aquaculture, plant and environmental biotechnology, and bioengineering.

The university's tropical locale, the importance of agriculture in the economy of this region, and the strong basic orientation of our faculty combine into unique interdisciplinary research and educational opportunities that range from molecular biology and biochemistry to agricultural biotechnology and bioengineering. The program stresses solid foundation in fundamentals, competence in contemporary methods and significant research contributions to plant biology, environmental biochemistry and tropical agricultural biotechnology.

### Entrance Requirements

- Minimum qualifications for admittance as a regular student are an undergraduate degree from an accredited U.S. college or university or equivalent degree from a recognized foreign institution of higher learning and a GPA of at least 3.0 on a 4.0 scale.
- All prospective students must submit scores from the GRE General Test. In cases where foreign students encounter

difficulty in taking the examination, submission of scores may be delayed with permission from the Graduate Division. Foreign students must also submit TOEFL scores (see Graduate Bulletin for exceptions.)

- All applicants are expected to have completed courses or equivalents in calculus, physics, chemistry through organic and quantitative analysis, basic biology or botany, genetics, biochemistry, plant physiology, and one additional upper division course in either botanical sciences, 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 Requirements

- All degree requirements shall be those in effect and published in the Graduate Bulletin as of the date of the initial enrollment in the graduate program. All students shall adhere to policies and procedures as established by the University, the Graduate Division, and the Department.
- The Graduate Chair or representative shall temporarily advise new students until a major adviser is selected. Uncommitted students should be fully cognizant of the faculty and their programs before selecting a Graduate Advisory Committee Chair. The Graduate Chair must be informed of the selection. In unusual situations, a student may change a Graduate Advisory Committee Chair but only after consultation with all faculty concerned and approval of the temporary or permanent Graduate Advisory Committee.
- Upon entering the graduate program, each student shall be assigned a temporary Graduate Advisory Committee appointed by the Graduate Chair. The committee will consist of the Graduate Chair and at least two (2) other members of the MBBE Graduate Faculty. This committee shall advise the student on course selection matters, administer the general examination, insure progression in the program, and advise the student until the permanent Graduate Advisory Committee is established.
- All students shall take a written diagnostic examination during the first semester of residence. The purpose of this examination is to determine the level of understanding in general botany, cytology, anatomy, morphology, biochemistry, and physiology. The length of the examination shall be a maximum of two hours. The date and place shall be determined by the Graduate Chair. The examination shall be administered by a committee of three members of the MBBE Graduate Faculty. Performance on this examination will be used to determine deficiencies.
- Each student shall meet with the student's temporary or permanent Graduate Advisory Committee at least once each semester to access academic and reassert 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 Chair.

- All graduate students are encouraged to take MBBE 401 Molecular Biotechnology or an equivalent course as a prerequisite. In addition, a minimum of three (3) of the following 600-level courses are selected with the approval of the Graduate Advisory Committee and the Graduate Chair.
  - MBBE 620 Plant Biochemistry
  - MBBE 680 Methods in Plant Molecular Biology
  - MBBE 687 Advanced Lab Techniques
  - BE 604 Aquaculture Systems
  - BE 606 Instrumentation and Measurement
  - BE 622 Experimental Methods in Cause-Effect Modeling
  - BE 638 Biosystems Modeling
  - BE 648 Biosystems Simulation
  - BE 660 Bioseparation Processes
  - BE 634 Biological Treatment
  - CHEM 633 Molecular Spectroscopy
  - PEPS 630 Plant Virology
  - PEPS 646 Plant Bacterial Interactions
  - PEPS 681 Pesticide Toxicology
  - BOT 669 Molecular Systematics and Evolution
  - BOT 674 Plant Growth and Development
  - CMB 621 Cell Molecular Biology I
  - CMB 622 Cell Molecular Biology II
  - CMB 680 Molecular Genetics
  - MICR 625 Advanced Immunology
  - MICR 632 Advanced Microbial Physiology
  - MICR 671 Advanced Microbial Genetics
  - TPSS 440 Tissue Culture/Transformation
  - TPSS 604 Advanced Soil Microbiology
  - TPSS 614 Cellular Genetics of Crops
  - OCN 653 Methods in Microbiology Oceanography

■ MBBE 610 Seminar: All MBBE graduate students shall register for and present a seminar each semester in residence (excluding summer sessions). This requirement can be met by enrolling in MBBE 610, or other equivalent "presentation type" seminar offered in another department with permission of the Graduate Advisory Committee. Thesis/dissertation proposal seminars or defenses cannot be used to meet this requirement.

■ All MBBE graduate students shall maintain a B average (3.0) to be eligible for advancement within a degree program.

### Additional Requirements

All MS students are encouraged to submit a thesis (Plan A). Only under very special circumstances, a student may be advised to pursue a MS degree without a thesis (Plan B), which is considered to be a terminal degree. MS Plan A requires a minimum of 12 credit hours of 600 level courses (excluding directed research), 6 credit hours of 400 or higher level courses, and 9 credit hours of research (MBBE 699). The course requirement for each student will be determined in consultation with the Graduate Advisory Committee and the Graduate Chair.

### Contact Information

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## Natural Resources and Environmental Management

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### Faculty

- \*S. A. El-Swaify, PhD (Chair)—natural resource degradation, erosion, conservation, water quality
- \*R. L. Bowen, PhD—natural resource policy, economics, sustainable agriculture
- \*C. Chan-Halbrecht, PhD—community and resource economics
- \*C. Ching, PhD—policy and production economics
- \*L. J. Cox, PhD—community economic development
- \*R. de la Peña, PhD—crop management, root crops
- \*C. I. Evensen, PhD—natural resource management, environmental quality
- \*C. A. Ferguson, PhD—natural resource and environmental policy
- J. B. Friday, PhD—tropical forestry/agroforestry extension
- \*J. H. Fownes, PhD—forest ecology
- \*P. V. Garrod, PhD—marketing and production economics
- \*C. Gopalakrishnan, PhD—natural resource and environmental economics and policy
- P. S. Motooka, PhD—weed science, forest/pasture weed control
- S. Y. Nagano, MS—4-H youth program, county extension
- \*G. R. Vieth, PhD—resource management, nonmarket valuation
- D. Ward, MS—4-H development program
- \*J. F. Yanagida, PhD—product economics, price analysis, international trade

### Cooperating Graduate Faculty

- J. DeFrank, PhD (TPSS)—herbicide management
- M. Habte, PhD (TPSS)—soil ecology, microbiology
- N. V. Hue, PhD (TPSS)—organic cycling
- P. S. Leung, PhD (MBBE)—production, fisheries, aquaculture
- Q. Li, PhD (MBBE)—environmental chemistry
- C. Ray, PhD (CEE)—ground water hydrology and chemistry
- G. Uehara, PhD (TPSS)—systems simulation in agriculture
- H. Valenzuela, PhD (TPSS)—vegetation physiology and management

### Affiliate Graduate Faculty

J. Ewel, PhD (US Forest Service)—forest ecology  
 K. Ewel, PhD (US Forest Service)—forest/wetland ecology  
 S. Pooley, PhD (NMFS)—marine resource economics

**Degrees and Certificates Offered:** BS, MS, and PhD in Natural Resources and Environmental Management, and Graduate Resource Management Certificate (See the “Interdisciplinary Programs” section within the UHM *Catalog*)

### Overall Goals of the Academic Program

The Natural Resources and Environmental Management program emphasizes the science and management of natural, including renewable, resources and their interlinks to environmental quality. It provides students with scientific knowledge of the physical, chemical, biological, economic, social, and policy elements of natural resources management and so allows them to understand the principles that underpin productive, sustainable land 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, and landscapes in an ecologically sound matter. Graduates will also be skilled in addressing resource policy issues and the needs of diverse clientele and communities including policy makers and planners. Scientific objectivity will be emphasized as an important element of environmental planning. Thus, students will be trained in the use of quantitative models and such tools as decision aids for optimizing natural resource management and ecosystem stewardship.

### Undergraduate Study

#### **BS in Natural Resources and Environmental Management (NREM)**

The Bachelor’s of Science in Natural Resource and Environmental Management (NREM) 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 resource systems, 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, real-life problem-solving including community experiences. There are also options for students to develop an individual specialization in their upper division study. Graduates have many challenging and rewarding career opportunities with governmental 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 and environmental resources and related fields.

### Advising

Undergraduate majors are required to report for advising prior to registration each semester. Students will be advised by the *Undergraduate Advisement Committee* until they declare a track specialization, at which time they will be assigned to a faculty mentor. The mentor will assist the student in developing an appropriate program of study in his/her track, approve track depth electives, and provide advisement through completion of the degree.

### Entrance Requirements

Freshmen may be admitted directly into the program when they apply to the University. Students transferring from another program in the University of Hawai‘i system or other universities must have a minimum 2.5 GPA for transferable credits.

### Degree Requirements

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

- GEOG 101/101L
- CHEM 161/161L or 171/171L
- BIOL 171/171L and BIOL 172/172L
- One course from MATH 203, 215, 241, or NREM 203
- GEOG 370 and ES 350

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

- SP 151 or 251
- NREM 210 and 220
- NREM 301/301L, 302, and 310
- NREM 458 and 492

### Specializations and their Requirements

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

**Specialization in Resource Management and Conservation:** This track focuses on the biological/physical and natural science aspects of resource management. Course requirements include:

- CHEM 162/162L and PHYS 151/151L
- TPSS/NREM 304/304L
- GEOG 488
- 15 upper division credits in natural resource specialization area, with at least one course that emphasizes analytical or field research methods (course selection requires adviser approval).

**Specialization in Resource Development and Policy:**

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

- NREM 351 and FAMR 352
- One course from GEOG 412, 441, or 455
- 12 upper division credits from social science disciplines (anthropology, economics, geography, political science, sociology) with at least 9 credits in a single discipline and no more than one course from a closely related multidisciplinary social science program (course selection requires adviser approval)
- 3 upper division credits in social science analytical/field research methods or in advanced communication (COM, JOUR, SP) methods
- 6 upper division credits in specific natural resource area(s) or field study methods

**Options for Meeting UH Manoa Hawaiian/ Second Language Requirement**

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

**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 UHM courses in the respective area.

**Graduate Study**

The NREM graduate program brings together natural and social scientists to offer a holistic, integrative, multi-/inter-disciplinary program that uses a systems approach to understanding and managing tropical terrestrial ecosystems. Emphasis is placed on small island settings and their relevance to managing coastal zones in general. It will incorporate the various components and scales (spatial and temporal) that determine ecosystem function and that bear upon the social and economic welfare of residents in different communities and environmental settings. Curricula and courses will emphasize the cutting-edge physical, chemical, biological, economic, social, and policy sciences underpinning the productive, profitable, and sustainable use and management of natural, environmental, and economic resources. The program

will also provide a science-based understanding of the processes that control the performance and function of terrestrial ecosystems, and the human behaviors and policies that impact, and are impacted by those processes.

Students will be expected to acquire quantitative reasoning, critical thinking, and other advanced skills that enable them to solve contemporary resource use problems and to assist in sound decision-making and policy formation. Graduates will be skilled in resolving land use conflicts that arise in addressing policy issues and the competing needs of diverse clientele and communities, including policy makers, planners, and other decision makers. Scientific objectivity will be emphasized as an important element of societal debate and state-of-the-art environmental planning. Thus, students will be trained in the development and use of quantitative models and such tools as multiple objective decision aids for optimizing the use and management of the natural resource base.

Natural resource 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, will feature collaboration with national and international institutions to foster programs that provide students with opportunities to learn about the ways that people from other countries and cultures manage their natural, including renewable, resources and interact with their environments.

Graduating students are expected to serve as professionals in resource and environmental management and policy, academic teaching and research, or applied research and outreach in educational and research institutions, federal and state technical assistance and policy agencies, agricultural and forestry industries, consulting firms, and private nonprofit organizations.

**Specialization Areas and Their Requirements**

NREM is a multidisciplinary department that is uniquely positioned to offer the integrative graduate curricula that are necessary for informed decision-making and action-oriented holistic natural resource and environmental management. As a fundamental foundation in graduate training, all NREM students are expected to acquire a common base of knowledge embodied in a core set of courses. However, NREM faculty are also cognizant that emphasizing problem solving and multidisciplinary may be misunderstood as a dilution of the scientific rigor that is expected to characterize graduate training, especially at the doctoral level. Therefore, students will be provided an opportunity to select a specific area of specialization. Two primary areas of specialization will be available, namely **Resource Management and Conservation, and Resource and Environmental Economics**. The first is a biological-physical area that includes the characterization, quality, productivity, behavior, management, protection, conservation, and remediation of natural resources in terrestrial ecosystems. The second is a socioeconomic area that includes the economic analysis of the ownership, allocation and pricing of natural resources, including inter-temporal and inter-

generational dimensions, environmental quality and externalities, market—and non-market valuation techniques, and the role of institutions and laws in natural resource and environmental policy formulation.

While we will require a common nucleus of multidisciplinary courses as a core, we will also require an additional core designed to provide advanced training in the chosen primary specialization area. Further course work beyond these cores will be selected from a pool of elective courses with guidance from the student's Program Committee.

Specific specializations in the **Resource Management and Conservation** area include land resource inventory and interpretation; tropical forestry and agroforestry; sustainable land management; land degradation processes and models including erosion, salinization and sedimentation; land, soil and water conservation, reclamation and remediation; water quality; nonpoint source pollution, contaminant sources and transport in watershed agroecosystems; and byproduct recycling potentials and environmental impacts. Specific specializations in the **Resource and Environmental Economics** area include ecological and environmental economics; non-market valuation in resource allocation and policy development; water resource allocation, economics and policy; economics of sustainable resource utilization; forest economics; community economic development; land and water use economics and policy, and conflict resolution and multi-criteria decision support systems for integrated resource management.

To underscore its integrative nature, the NREM Graduate Program features strong collaboration with other academic departments within and outside CTAHR, as well as selected collaborating institutions in and out of Hawai'i. Cooperating- and affiliate-graduate faculty with appropriate expertise will complement NREM's faculty expertise for the benefit of graduate students.

NREM intends to facilitate enrollment of qualified neighbor island citizens in graduate study through the participation of neighbor island faculty and the use of distance education and other interactive electronic technologies.

NREM is also an active partner in offering the multidisciplinary campus-wide Graduate Resource Management Certificate.

## Admission Requirements

Applicants for graduate standing must have a bachelor's degree with the qualifications necessary to gain admission to the UHM Graduate Division. Those cleared through the Graduate Division will be evaluated by the department based on previous academic record and specific criteria that include the graduation requirements for the B.S. degree in NREM, the GRE score, chosen area of specialization, recommendation letters, and prior research or professional experience. M.S. applicants must have a B.S. degree in natural resource management, environmental management, or a related field in a biological, physical, or social science discipline. Those opting for the Resource Management and Conservation specialization

area must show a minimum of 15 credits in prior preparation in physical, biological and/or earth sciences, mathematics, or equivalent courses. Those opting for the Resource and Environmental Economics specialization need a minimum of 15 course credits in social sciences to include resource economics, mathematics, management, quantitative analysis or comparable courses.

Applicants for the Ph.D. degree are required to have an M.S. degree in NREM or a related field with background courses similar or equivalent to those described below for the M.S. core in NREM.

The minimum **TOEFL** score required of foreign students is 600 and 250 for Type P or Type C examinations, respectively.

## Advising

Admitted students will be advised on an interim basis by the Graduate Program **Interim Advising Committee** which is appointed by the Graduate Program Chair. The primary tasks of this committee are to administer the diagnostic examination (see below), verify entrance and background deficiencies, and prescribe remedial courses. A **Student Program Committee** (thesis or dissertation committee) with a chair whose expertise coincides best with the student's chosen specialization area will be formed as soon as possible after admission. This committee will guide the student's program, advise on the selection of required and elective courses, assist with and approve the selection of a thesis/dissertation research topic that is appropriate for the chosen area of specialization, administer the required Comprehensive and Defense examinations, and oversee the completion of degree requirements.

## Admission Requirements

### M.S. Degree Program

It is expected that the course preparation for admitted students with a BS degree will be the same, be equivalent to, or exceed those core areas required for the B.S. degree in NREM. With no deficiency in this background, the required minimum number of course credits for the MS degree will be the same as required by the Graduate Division. Plans A, B, and C will be offered. Plan A will require the usual number of 700 thesis credits specified by the Graduate Division. Plan B will be primarily course-driven. Plan C will be available to selected students based on their prior academic record and experience. Either the *Interim Advising Committee* or *Student Program Committee* may recommend entering students for pursuing this option which requires the steps stated on page 45 of the 2001-2002 UHM Catalog.

Because NREM is a multi-/inter-disciplinary program, entering students are expected to come from a variety of disciplines. Therefore, each will be given a diagnostic examination by the *Interim Advising Committee* before or shortly after the beginning of their first semester of enrollment. The examination's results will be used as a guide in designing the

student's program. Identified undergraduate deficiencies, if any, must be corrected as part of the student's course work.

Each student will select a Specialization Area with the approval of the *Student Program Committee* as early as possible following enrollment in the graduate program. To meet the integrative, inter-disciplinary intent of this program, a set of graduate level courses, a *Primary Core*, will be required of every student, regardless of his/her selected Specialization Area. In addition, a *Secondary Core* that prepares the student for the selected Specialization Area will also be required. The remaining credit requirements will be met by thesis credits (NREM 700), Directed Research (NREM 699), and elective courses that are approved by the *Student Program Committee*.

#### **Primary M.S. core (12 Cr)**

- HNFAS/TPSS 603 Experimental Design (4)
- NREM 680 Natural Terrestrial Ecosystems (3)
- NREM 670 Agrarian Systems Analysis (3)
- NREM 701 Research Seminar in NREM (2)

#### **Secondary core for Resource Management and Conservation specialization area (9 Cr)**

- NREM 610 Soil Formation and Classification (4)
- NREM 631 Sustainable Agriculture Seminar (2)
- NREM 660 Hydrologic Processes in Soils (3)

#### **Secondary Core for Resource and Environmental Economics specialization area (9 Cr)**

- AREC 626 Quantitative Methods in Agricultural Economics (3)
- AREC 627 Applied Microeconomic Analysis (3)
- ECON 627 Mathematics for Economics (3)

### **Ph.D. Degree Program**

The PhD degree in NREM will be awarded only to students with outstanding scholarly achievement. PhD standing may be provisionally granted to applicants with a BS degree, but only if they have strong academic background and a high GRE score. However, these applicants may still be required to obtain an MS degree in NREM before formal admission to PhD candidacy. Those with academic records that do not match the NREM core requirements will be expected to incorporate these into their PhD program. In addition, to meet the integrative, inter-disciplinary intent of this program, a set of graduate level courses, a *Primary Core*, will be required of every student, regardless of his/her selected Specialization Area. In addition, a *Secondary Core* that prepares the student for the selected Specialization Area will also be required. The remaining degree requirements will be met by dissertation credits (NREM 800), Directed Research (NREM 699), and elective courses that are approved by the *Student Program Committee*. All PhD students must pass a written and oral Comprehensive Examination (described below), before being advanced to candidacy. The *Student*

*Program Committee* will be responsible for designing and administering the Comprehensive Examination.

#### **Primary Ph.D. core (9 Cr)**

- NREM 630 Agriculture and the Environment (3)
- AREC 638 Resource and Environmental Policy (3)
- NREM 701 Research Seminar in NREM (3)

#### **Secondary core for Resource Management and Conservation specialization area (18 Cr)**

- NREM 611 Soil and Clay Mineralogy (3)
- CEE 626 Surface Water Hydrology (3)
- CEE 627 Groundwater Hydrology (3)
- CEE 644 Water Quality Modeling (3)
- GEOG 628 Resource Systems (3)
- OCN 638 Earth System Science and Global Change (3)

#### **Secondary Core for Resource and Environmental Economics specialization area (18 Cr)**

- AREC 634 Quantitative Methods II (3)
- ECON 627 Mathematics for Economics (3)
- ECON 606 Microeconomic Theory I (3)
- ECON 607 Macroeconomic Theory I (3)
- ECON 608 Microeconomic Theory II (3)
- NREM 637 Resource Economics (3)

### **Comprehensive Examination**

PhD candidates must pass a two-part (written and oral) *Comprehensive Examination* upon completion of the required course cores, and before being advanced to candidacy. The *Student Program Committee* will be responsible for designing and carrying out the *Comprehensive Examination* which is to follow the preparation of the Dissertation Proposal. The examination is intended to cover all the subjects deemed essential to the selected specialization area, and to verify the student's preparedness for carrying out the proposed dissertation research. Each member of the *Student Program Committee* will submit a set of questions for the written portion of the examination. Therefore, the number of specific fields represented in these questions is a function of and up to the members of the *Student Program Committee*. The oral portion will follow as soon as possible after the written portion of the *Comprehensive Examination*.

### **Course Pool for Suggested Electives**

The following is a tentative course pool to guide student advising. Student course choices will be guided by the *Student's Program Committee*.

- NREM 432 Natural Resource Economics (3)
- NREM 458 Project Evaluation and Resource Management (3)
- NREM 461 Soil Erosion and Conservation (3)
- NREM 480 Tropical Forestry/Agroforestry (3)
- NREM 491 Topics in NREM (V)
- NREM 500 Master's Plan B/C Studies (V)
- NREM 626 Quantitative Methods I (3)
- NREM 671 International Agricultural Systems (2)
- NREM 699 Directed Research (V)

- NREM 701 Seminar in Advanced NREM (1)
- AREC 610 Biosystems Modeling (3)
- AREC 624 Research Methodology (3)
- AREC 629 Adv Production Economics (3)
- AREC 631 International Trade in Agricultural Products (3)
- AREC 636 Advanced Agricultural Policy Analysis (3)
- ANTH 415 Ecological Anthropology (3)
- ANTH 435 Human Adaptation to Forests (3)
- ANTH 620H Theory in Social and Cultural Anthropology: Ecology (3)
- BE 413 Transport Phenomena (3)
- BE 431 Biological Pollution Control (3)
- BE 440 Bioremediation Principles and Practices (3)
- BOT 453 Plant Ecology and Env Measurement (3)
- BOT 454 Vegetation Ecology (3)
- BOT 651 Invasion Biology (3)
- BOT 676 Environmental Physiology Seminar (2)
- CEE 424 Applied Hydrology (3)
- CEE 431 Water and Wastewater Engineering (3)
- CEE 624 Flow Through Porous Media (3)
- CEE 631 Water Quality Management (3)
- CEE 635 Water Quality Chemistry (3)
- CEE 636 Water Quality Biology
- CEE 642 Solid Wastes Management and Control (3)
- ECON 638 Env Economics (3)
- GEOG 402 Agric Climatology (3)
- GEOG 410 Human Role in Env Change (3)
- GEOG 426 Energy Resources (3)
- GEOG 612 Ecological Concepts and Planning (3)
- GEOG 693 Technology and Natural Risks (3)
- GG 455 Hydrogeology (3)
- GG 654 Groundwater Contamination (3)
- LAW 582 Env Law (3)
- LAW 588 Legal Aspects of Water Resources Control (3)
- PH 689 Water Quality Chem (3)
- PH 690 Water Quality, Biology (3)
- PH 773 Measurement of Env Factors (3)
- PH 774 Water Quality management (3)
- PLAN 620 Env Planning (3)
- PLAN 625 Env Policies and programs (3)
- PEPS 451 Env Law (3)
- PEPS 470 Forensic Entomology (3)
- PEPS 671 Insect Ecology (2)
- PEPS 675 Biological Control (2)
- POLS 670 Introduction to Public Policy (3)
- SCI 490 Endangered Species (3)
- TPSS 435 Soil Chemistry (3)
- TPSS 450 Soil Fertility (3)
- TPSS 650 Advanced Soil Fertility (4)
- TPSS 604 Advanced Soil Microbiology (4)
- ZOO 439 Animal Ecology (3)

## Plant and Environmental Biotechnology Program

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 Web: www.ctahr.hawaii.edu/ctahr2001/CTAHRCatalog/pub.html

### Biotechnology Area Advisory Committee

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

### Participating Faculty

A. Brown, PhD—complementary medicine, botanicals, herbs  
 D. Dooley, PhD—biotechnology education  
 J. S. Hu, PhD—transgenic disease resistance  
 A. R. Kuehnle, PhD—genetic engineering and tissue culture  
 M. Kumagi, PhD—viral transfection systems  
 P. S. Leung, PhD—biotechnology economics  
 Q. Li, PhD—environmental biochemistry  
 R. E. Paull, PhD—tropical fruit biotechnology  
 W. W. Su, PhD—cell culture, biochemical engineering  
 J. P. Szyper, PhD—marine biotechnology  
 C. S. Tang, PhD—biochemistry of natural products  
 A. Wiczorek, PhD—molecular systematics, public education on biotechnology

**Degrees Offered:** BS in plant and environmental biotechnology

### Program Goals

- To provide education leading to biotechnology literacy.
- To provide training in the emerging scientific concepts underpinning biotechnology.
- To ensure training is broad based.
- To ensure students will be able to work as members of interdisciplinary teams.

### The Academic Program

During the past decade, biotechnology has brought about major changes in agricultural sciences and society. The interdepartmental Plant and Environmental Biotechnology program is designed to train undergraduate students for careers in new and growing areas of the life sciences emphasizing the use of biotechnology in agriculture, environmental clean-up and management, industry, teaching, and other professions.

The program provides a strong foundation in molecular biology, biochemistry, genetics, biotechnology, and the life sciences.

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

## Undergraduate Study

### **BS in Plant and Environmental Biotechnology**

#### Requirements

Students must fulfill the General Education Requirements of the University and college.

Among the courses they must include in these requirements are:

- NREM 310 (statistics)
- MATH 215 or MATH 241 (calculus)
- Foreign languages or options
- BIOL 171/171L; 172/172L; 275/275L
- CHEM 161/161L; 162/162L; 272/272L
- PHYS 100/100L or 151/151L; 152/152L
- NREM 220
- SP 151

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

- MBBE 201 (biotechnology issues and impacts)
- MBBE 401 (molecular biotechnology)
- MBBE 402/402L (biochemistry)
- PEPS 471 (genetics)
- MBBE/PEPS/TPSS 499 (lab rotation)
- MBBE/PEPS/TPSS 499 (senior thesis)

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

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

#### Required Courses:

- CHEM 272/272L (organic chemistry)
- MBBE 412 (environmental biochemistry)

- MICR 351/351L (biology of microbes)
- MICR 485/485L (microbes in environment)
- 15-19 credits from among GEOG 101/101L, BIOL 124/124L, CHEM 274/274L, PEPS/MBBE 403, CHEM 445, BE 431, MBBE 420, PEPS 480, MICR 475/475L, MICR 461/461L, PEPS 405, MICR 431/431L, BIOL 406/406L, PEPS/MBBE 403, MBBE/PEPS/TPSS 499 additional credits beyond 3

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

#### Required Courses:

- BIOL 102/102L (botany)
- BOT/TPSS 470/470L (plant physiology)
- TPSS 453 (plant breeding)
- TPSS 440 (tissue culture/transformation)
- PEPS 405 (plant pathogens and diseases)
- 13 credits from among BOT 410, BIOL 124/124L, BIOL 265/265L, OCN 310/310L, MBBE/PEPS/TPSS 499 additional credits beyond 3

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

#### Required Courses:

- BIOL 407 (molecular biology)
- MBBE 420 (plant molecular biology)
- BIOL 406/406L (cellular biology)
- 18 credits from among MICR 485/485L, MICR 351/351L, ENTO 470, CHEM 273/273L, MICR 475, TPSS 440, TPSS 453, MICR 461, OCN 310/310L, ANSC 450, PEPS/MBBE 403, PEPS/MBBE 404, MBBE/PEPS/TPSS 499 additional credits beyond 3

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

#### Required Courses:

- PEPS 363 (general entomology)
- PEPS 405 (plant pathogens and disease)
- PEPS 421 (pest management)
- PEPS 470 (forensic entomology)
- MBBE 412 (environmental biochemistry)
- 13-14 credits from among PEPS 462, PEPS 403, PEPS 404, MBBE/PEPS/TPSS 499 additional credits beyond 3

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

#### Required Courses:

- ZOO 320/320L (vertebrate zoology)
- BE 431 (biological pollution control)
- BE 460 (bioreactor design and analysis)
- 16-20 credits from among OCN 201, OCN 331, ANSC 360, ZOO 475/475L, ANSC 430, BE 436, ANSCI 460, MBBE/PEPS/TPSS 499 additional credits beyond 3

## Plant and Environmental Protection Sciences

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Web: [www.ctahr.hawaii.edu/ctahr2001.CTAHRCatalog/peps.html](http://www.ctahr.hawaii.edu/ctahr2001.CTAHRCatalog/peps.html)

#### Faculty

- \*J. K. Grace, PhD (Interim Chair)—urban entomology, termite and social insect biology and control, insect behavior
- \*A. M. Alvarez, PhD—bacterial diseases
- \*B. M. Brennan, PhD—pesticide regulation and use
- \*J. J. Cho, PhD—diseases of vegetable crops, integrated pest management (Maui Agricultural Research Center)
- R. H. Ebesu, MS—extension education (Kaua'i Cooperative Extension Service)
- \*S. A. Ferreira, PhD—crop protection, extension education
- R. T. Hamasaki, MS—fruit and vegetable crops extension education (O'ahu Cooperative Extension Service)
- \*A. H. Hara, PhD—horticultural entomology, post-harvest insect control, regulatory entomology (Beaumont Agricultural Research Center, Hilo)
- \*J. Hu, PhD—virology
- \*M. W. Johnson, PhD—biological control, insect pest management
- \*M. Kawate, PhD—pesticide registration
- \*W. H. Ko, PhD—soil microbiology (Beaumont Agricultural Research Center, Hilo)
- \*R. F. L. Mau, PhD—agricultural entomology, entomology extension education, insect biology
- E. F. Mersino, MS—Ornamental crops extension education (O'ahu Cooperative Extension Service)

- \*R. H. Messing, PhD—insect ecology and biological control (Kaua'i Agricultural Research Center)
- N. M. Nagata, MS—urban horticulture, cut flowers and fruits extension education
- \*S. C. Nelson, PhD—epidemiology, extension education
- \*R. K. Nishimoto PhD—weed science
- \*W. T. Nishijima, PhD—tropical fruits and nuts, forest and tree diseases, ornamental extension education (Beaumont Agricultural Research Center, Hilo)
- \*J. J. Ooka, PhD—diseases of coconuts, 'awa, corn, soybeans, sunflowers, taro, ginger, medicinals, spices; disease suppressive composts (Kaua'i Agricultural Research Center)
- \*K. G. Rohrbach, PhD—pineapple diseases, integrated pest management
- D. M. Sato, MS—extension education (Hawai'i Cooperative Extension Service)
- \*S. H. Saul, PhD—insect genetics
- \*D. Schmitt, PhD—tropical nematology, nematode ecology and management
- \*J. Seifert, PhD—biochemical toxicology
- 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
- \*E. E. Trujillo, PhD—soil-borne diseases, biological control of weeds
- \*J. Y. Uchida, PhD—fungal pathology, biological control of diseases, environmental impacts
- \*M. G. Wright, PhD—integrated pest management, tropical fruits and nuts, insect ecology, biological control
- \*J. R. Yates III, PhD—urban pest management, termite biology and control

#### Cooperating Graduate Faculty

- L. Arita-Tsutsumi, PhD—insect behavior, honeybee ecology (UH Hilo)
- D. Borthakur, PhD—molecular biology
- J. K. Fujii, PhD—insect pathology, termite biology (UH Hilo)
- K. Y. Kaneshiro, PhD—systematics, evolution, insect behavior
- M. Kumagai, PhD—molecular biology
- S. S. Patil, PhD—host parasite physiology
- M. Shintaku, PhD—virology (UH Hilo)

#### Affiliate Graduate Faculty

- J. W. Armstrong, PhD—commodity quarantine treatments, fruit fly control (USDA-ARS, Hilo)
- C. K. Atkinson, PhD—wildlife disease (US Fish and Wildlife Service)
- N. Evenhuis, PhD—systematics of *Diptera* (Bishop Museum)
- P. A. Follett, PhD—commodity quarantine treatments, tropical tree fruit IPM (USDA-ARS, Hilo)
- D. Gardner, PhD—pathology of native vegetation
- M. L. Goff, PhD—medical and forensic entomology (Chaminade University)
- E. J. Harris, PhD—ecology and control of fruit flies (USDA-ARS)
- F. G. Howarth, PhD—systematics (Bishop Museum)

- E. B. Jang, PhD—insect physiology, fruit fly control (USDA-ARS, Hilo)  
 S. D. McCombs, PhD—biotechnology, genetics (USDA-APHIS)  
 D. O. McInnis, PhD—insect genetics (USDA-ARS)  
 N. J. Reimer, PhD—ant biology and control, biological control of weeds (Bishop Museum)  
 G. A. Samuelson, PhD—systematics (Bishop Museum)  
 R. I. Vargas, PhD—ecology, mass-rearing techniques (USDA-ARS, Hilo)

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

## The Academic Program

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

### Affiliations

Studies in Plant and Environmental Protection Sciences at the University of Hawai'i are strengthened by cooperative relationships with the following units: Multidisciplinary Graduate Programs of the Cell, Molecular, and Neurosciences; Ecology, Evolution, and Conservation Biology Program; Harold L. Lyons Arboretum; Hawai'i Agriculture Research Center; B. P. Bishop Museum; Agricultural Research Service of the United States Department of Agriculture; Animal and Plant Health Inspection Service of the United States Department of Agriculture; and Hawai'i Department of Agriculture.

### Advising

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

## Undergraduate Study-B.S. Degree

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

### Requirements-(128 credit hours)

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

Specific requirements are:

- BIOL 171, 171L, 172, 172L; or 102, 102L, 103, 103L; or 102, 102L, 123, 123L; or 102, 102L, 124, 124L
- CHEM 151, 151L; or 171, 171L; or 161, 161L, 162, 162L
- CHEM 152, 152L; or 272, 272L, 273, 273L
- SP 151
- ENG 100
- NREM 310
- HIST 151, 152
- TPSS 200
- PEPS: 363, 405, 481, and 495; 1 course numbered from 200 to 399; 6 credits of 499; and 12 credit hours of courses numbered from 400 to 499.
- 29 additional credit hours of approved electives based upon students' academic interests.
- Additional credit hours as necessary to meet UH Mānoa general education requirements.
- Hawaiian / Second Language Requirement: Undergraduate students in PEPS, in consultation with their undergraduate adviser, will be asked to select one of the following three options:
  - Option 1: Show proficiency in a Hawaiian/Second Language at the 202 level;
  - Option 2: Show proficiency in a Hawaiian/Second Language at the 102 level, and take one additional 3-credit semester course in the Social Sciences and one additional 3 or 4-credit semester course in Natural Sciences;
  - Option 3: Take two additional 3-credit semester courses in Social Sciences and two additional 3 or 4-credit semester courses in Natural Sciences. One of the courses in the Natural Sciences must include a laboratory.

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

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

### **Graduate Study-Entomology**

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

Students applying for graduate programs in entomology are expected to have acquired a bachelor's degree with credit hours in entomology and biology, including general biology, general entomology, integrated pest management; one year of chemistry; and an appropriate course in mathematics and/or statistics. Deficiencies in undergraduate preparation can be satisfied during the graduate program. Applications for admission must include GRE scores.

The 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), Plan B (non-thesis), or Plan C (examination). 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.

### **M.S. Plan A (Thesis)**

- 16 credit hours of course work including seminars.
- Students shall enroll in PEPS 660 Research Seminars in PEPS each semester, except when enrolled in PEPS 799.
- 1 credit hour of PEPS 690 Foundations in Plant and Environmental Sciences each year, with at least 2 credits required for graduation.
- 12 credit hours of PEPS 700 Thesis Research.
- 2 credit hours of PEPS 799 Proposal/Defense Seminar (C/N).
- Final oral defense and submission of acceptable thesis.

### **M.S. Plan B (Non-thesis)**

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

- 23 credit hours of course work including seminars.
- Students shall enroll in PEPS 660 Research Seminars in PEPS each semester.
- 6 credit hours of PEPS 699 Directed Research.
- 1 credit hour of PEPS 690 Foundations in Plant and Environmental Sciences each year, with at least 2 credits required for graduation.
- 1 credit hour of PEPS 799 Proposal/Defense Seminar (C/N) 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.

### **M.S. Plan C (Examinations)**

Students preparing for a career in research or admission to a doctoral program are advised to enroll in M.S. Plan A (thesis). M.S. Plan C is intended for students who have already acquired considerable expertise in entomology through prior course work, employment, or other educational venues.

Additional course work will be selected by the student in consultation with the advisory committee, and may include non-resident instruction. A two-semester, or four summer session, or one semester and two summer session, residency is required. The student must demonstrate competence in entomology through oral and/or written examinations, which may consist of discussion of a research or educational project, administered by the advisory committee in consultation with the Chair of the graduate program.

### **Doctoral Degree**

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

The goal of the PhD program is to have students possess broad general knowledge in all areas of entomology, in-depth knowledge in at least one area of specialization and develop the capability for independent research. Employment options for PhD graduates are in teaching, research, and extension at universities and in research, consulting or management with private industries and government agencies.

### **Requirements**

- 1 credit hour of PEPS 690 each year.
- 1 credit hour of PEPS 660 each semester, except when enrolled in PEPS 799.
- 2 credit hours of PEPS 799 Proposal/Defense Seminar (C/N).
- 1 credit hour of PEPS 800 Dissertation Research during semester of graduation.

- Additional course work as determined by the doctoral advisory committee.
- Oral and written comprehensive examination in the candidate's area of specialization administered by the doctoral committee.
- Final oral defense of the dissertation research and submission of an acceptable dissertation.

### **Graduate Study – Plant Pathology**

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

Students should have their undergraduate preparation in botany, horticulture, agronomy, microbiology, or plant and environmental protection sciences. Plant pathology has its foundation in biology and agriculture and offers wide opportunities in both basic and applied areas of biology, plant sciences, and agriculture. The plant pathology program at the University of Hawai'i 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.

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.

### **Master's Degree**

The MS degree program is offered under either Plan A (thesis), Plan B (non-thesis), or Plan C (examination). 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 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.

### **M.S. Plan A (Thesis)**

- Research: 12 credits in PEPS 700 Thesis Research, and submission of acceptable thesis.
- Courses: 16 credits in courses approved by the candidate's committee, including 10 credits in courses numbered 600-698, excluding PEPS 660 and 699, including at least 6 credits selected from PEPS 612, 616, 630, 646.

- Seminars: Minimum of 2 credits in PEPS 660, which is required each semester except when enrolled in PEPS 799; 2 credits in PEPS 799 (C/N) – C/N credits are not counted towards degree credit requirements.

### **M.S. Plan B (Non-thesis)**

- Research: 6-9 credits in PEPS 699 Directed Research, preferably taken in 2-3 different laboratories.
- Courses: 19-22 credits in courses approved by the candidate's committee, including 16 credits in courses numbered 600-698, excluding PEPS 660 and 699, including at least 6 credits selected from PEPS 612, 616, 630, 646.
- Seminars: Minimum of 2 credits in PEPS 660, which is required each semester except when enrolled in PEPS 799; 1 credit in PEPS 799 (C/N) – C/N credits are not counted towards degree credit requirements.

### **M.S. Plan C (Examinations)**

Students preparing for a career in research or admission to a doctoral program are advised to enroll in M.S. Plan A (thesis). M.S. Plan C is intended for students who have already acquired considerable expertise in plant pathology through prior course work, employment, or other educational venues. Additional course work will be selected by the student in consultation with the advisory committee, and may include non-resident instruction. A two-semester, or four summer session, or one semester and two summer session, residency is required. The student must demonstrate competence in plant pathology through oral and/or written examinations, which may consist of discussion of a research or educational project, administered by the advisory committee in consultation with the Chair of the graduate program.

### **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 PEPS 799.
- 2 credit hours of PEPS 799 Proposal/defense seminar (C/N).
- Comprehensive and final defense examinations.
- 1 credit hour of PEPS 800 Dissertation Research during semester of graduation.
- Submission of acceptable dissertation.

# Tropical Plant and Soil Sciences

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## Faculty

\*R. E. Paull, PhD (Chair)—plant growth and development, postharvest handling  
A. S. Arakaki, BS—junior extension agent, fruit and vegetable production  
R. Arce, BS—junior extension agent, community development, agricultural production  
\*H. C. Bittenbender, PhD—coffee, kava and tropical fruit physiology and management  
\*J. L. Brewbaker, PhD—plant breeding, biochemical genetics  
\*C. G. Cavaletto, MS—sensory evaluation, food processing  
I. S. Campbell, PhD—crop management, information systems  
\*C. L. Chia, PhD—tropical fruits  
\*R. A. Criley, PhD—floriculture, flowering physiology, plant propagation  
\*J. DeFrank, PhD—weed science  
\*K. D. Fleming, PhD—agribusiness management  
S. K. Fukuda, MS—extension agent, vegetable production  
\*M. Habte, PhD—soil microbiology-biochemistry  
C. S. Hashimoto, MS—extension agent, fruit production  
\*A. S. Hodgson, PhD—food technology extension, food safety and quality  
\*N. V. Hue, PhD—soil chemistry  
\*K. D. Kobayashi, PhD—fruit physiology and computer modeling  
\*B. A. Kratky, PhD—vegetable physiology and management  
\*A. R. Kuehnle, PhD—ornamental breeding and genetics  
\*K. L. Leonhardt, PhD—floriculture  
\*R. M. Manshardt, PhD—tropical fruit breeding and genetics  
\*K. Marcum, PhD—turfgrass management  
\*S. C. Miyasaka, PhD—alternative crops, plant nutrition  
\*M. A. Nagao, PhD—development physiology, growth regulation  
\*M. S. Nishina, MS—associate extension agent, tropical fruit production  
\*Y. Sagawa, PhD—developmental morphology, cytogenetics, tissue culture  
\*D. Sato, MS—educational specialist, urban horticulture  
\*J. A. Silva, PhD—soil fertility and soil chemistry, statistics  
\*P. Singleton, PhD—crop physiology, nutrient management  
V. E. Smith, MS—assistant extension agent, fruit and ornamental production  
\*K. Y. Takeda, PhD—solanaceous crops  
G. I. Teves, BS—junior extension agent, ornamentals production  
\*G. Uehara, PhD—systems simulation in international agriculture  
\*H. R. Valenzuela, PhD—vegetable physiology and management

W. K. Wong, PhD—extension agent, landscaping and nursery management  
R. M. Yamakawa, MS—associate extension agent, ornamentals production  
\*R. S. Yost, PhD—expert systems in soil management, fertility

## Cooperating Graduate Faculty

\*R. S. de la Pena, PhD—crop management, root crops  
\*S. A. El-Swaify, PhD—soil and water conservation, salinity  
\*C. I. Evensen, PhD—water quality extension, environmental education  
\*S. C. Furutani, PhD—horticultural crop physiology  
\*M. K. Kawate, PhD—pesticide registration/weed science  
\*R. K. Nishimoto, PhD—weed science  
\*W. S. Sakai, PhD—ultrastructure, physiological plant anatomy  
\*T. Sekioka, PhD—vegetable breeding and genetics  
\*M. J. Tanabe, PhD—in vitro propagation, turf management, plant propagation

## Affiliate Graduate Faculty

\*H. Albert, PhD—plant biotechnology, gene regulation  
\*H. T. Chan Jr., PhD—food processing, plant biochemistry  
\*M. M. M. Fitch, PhD—tissue culture, genetic engineering  
\*J. J. McHugh, PhD—vegetable management, integrated pest management  
\*P. Moore, PhD—plant development, sugar metabolism  
\*R. R. G. Ming, PhD—plant genomics, plant breeding  
\*C. N. Nagai, PhD—sugar cane genetics and tissue culture  
\*R. V. Osgood, PhD—weed science  
\*D. Ragone, PhD—ethnobotany, conservation  
\*F. Zee, PhD—plant breeding, genetics

**Degrees Offered:** BS, MS, and PhD in tropical plant and soil sciences

## Program Goals

Upon graduation, students will be able to:

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

## The Academic Program

The Tropical Plant and Soil Sciences (TPSS) program at UH Mānoa is unique. Students have an opportunity to take courses in tropical flower, fruit, vegetable and crop production, turf and landscape management, plant physiology, breeding and genetics, and soil science. They learn about the full spectrum of subjects and activities required to understand and responsibly manage land, water, crops, and their environments

for the benefit of humankind. In addition, they learn about the adaptation and application of new technologies, such as molecular biotechnology, computer-based systems, and the internet, to enhance plant production systems, assure a safe food supply, and protect the environment.

Our students come from many backgrounds including those with little practical environmental or agricultural experience. They have in common a keen interest in applying science for the purpose of finding practical solutions to problems. Mature students are especially welcome. The comprehensive undergraduate program affords students the opportunity to study molecules to whole plants to managed or natural ecosystems, thus providing backgrounds to a host of career prospects. Students majoring in TPSS prepare for careers including plant production and management, plant breeding and genetics, services, marketing, extension, research, and teaching. UHM 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, in individual entrepreneur including farming, and as middle and upper management in corporate agriculture. They work in increasing the food supply, improving food quality, and assuring food safety while protecting the environment and improving the quality of life. Undergraduates are encouraged to obtain practical experience, which involves research under the direction of a faculty member and work in a commercial industry via our internship program. Students have found satisfaction in applying their course work and research studies to challenging problems in business, environmental protection, land-use, and agricultural crop production.

### **Advising**

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

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

### **Undergraduate Study**

The program offers a BS degree in Tropical Plant and Soil Sciences with specializations in (1) Plant Sciences and Genetics, (2) Plant Production and Management, and (3) Environmental Soil Science. A student is required to complete 128 credits to graduate with a BS in TPSS.

### **Requirements**

Students must complete the General Education Requirements (Core) of the University. An updated list of the courses recommended that satisfy the University General Education Requirement is available from the undergraduate adviser. The University's Hawaiian/Second Language graduation requirement can be met by showing proficiency at the 202 level in a language, or showing proficiency at the 102 level in a language, plus one (3 Cr) course in Social Sciences and one (3 Cr) course in Natural Sciences, or taking two (3 Cr) courses in Social Sciences and two (3 Cr) courses in Natural Sciences. These courses may not be used to satisfy the University General Education Requirement.

The College has a core consisting of the following three courses that will satisfy parts of the University General Education Requirement:

- SP 151 or 251 Personal and Public Speech or Principles of Effective Public Speaking
- NREM 310 Statistics in Agriculture and Human Resources
- TPSS 492 Internship/directed studies (3 credits)

Students must complete the following three courses in the Department:

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

### **Option in Plant Sciences and Genetics**

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

Students selecting this option must take Biology 172/172L, 275/275L and 406/406L (or their equivalent), and Chemistry 16L/161L, 162/162L, 272/272L and 273 (or their equivalent). Some of these courses will fulfill part of the Natural Science requirement of the UH General Education Requirement. These courses are considered prerequisite to courses in the major.

### **Major (Option) Courses**

Take a minimum of 14 credits from the following:

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

### **Electives (variable number of elective credits)**

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

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

### Option in Plant Production and Management

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

Students selecting this option need to take Botany 101 and 101L (or their equivalent) or Biology 172 and 172L (or their equivalent) and Chemistry 151 and 151L and 152 and 152L (or their equivalent) to fulfill part of the Natural Science requirement of the UH core. These courses are considered prerequisite to courses in the major.

### Major (Option) Courses

The major requires 12 credits from:

- TPSS 369 Ornamental Plant Materials
- TPSS 350/405 Tropical Landscape Practices / Turfgrass Management
- TPSS 401/403 Vegetable / Tropical Fruit Production courses
- TPSS 402/404 Flower / Tropical Foliage Production courses
- TPSS 430 Nursery Management
- TPSS 420 Plant Propagation

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

- TPSS 304 Fundamentals of Soil Science
- TPSS 322 Marketing Perishable Products
- TPSS 450 Nutrient Mgmt Soils & Plants
- TPSS 481 Weed Science
- PEPS 363 General Entomology
- PEPS 405 Plant Pathogens and Disease

### Elective Courses (variable number of elective credits)

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

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

### Option in Environmental Soil Science

The Environmental Soil Science option will prepare students to effectively manage soil for the production of agricultural commodities and preserve this important natural resource for the benefit of man and the protection of the environment.

Students selecting this option need to take Botany 101 and

101L (or their equivalent) or Biology 172 and 172L (or their equivalent), Chemistry 151 and 151L and 152 and 152L or 161, and 161L and 162 and 162L (or their equivalent), Economics 130, Physics 151 and 151L, Business writing (English 209) and Calculus I - Mathematics 215. Some of these courses will fulfill part of the Natural Science requirement of the UH General Education Requirement. These courses are considered prerequisite to courses in the major.

### Major Courses

The following courses need to be taken for this major.

- TPSS 304 Fundamentals of Soil Science
- TPSS 435 Environmental Soil Chemistry
- TPSS 450 Nutrient Mgmt Soils & Plants
- NREM 301 Natural Resource Management

### Electives

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

- TPSS 460 Plant Soil Atmosphere Physics
- TPSS 499 Directed Study
- NREM 461 Soil Erosion and Conservation
- MICRO 485 Microbial Ecology
- MET 101 Introduction to Meteorology
- GEOG 101/101L The Natural Environment
- ICS 101/ 101L Tools for the Computer Age

## 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 Tropical Plant and Soil Sciences, will provide considerable flexibility in the development of a program suited to a student's career objectives.

The department offers graduate study leading to the MS (Plan A, Plan B and Plan C) and PhD degrees. The TPSS graduate program offers a degree in Tropical Plant and Soil Sciences, and an option in Tropical Plant and Soil Sciences (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 Tropical Plant and Soil Sciences 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 Tropical Plant and Soil Sciences 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 of all applicants. A minimum CBT TOEFL score of 173 is required of all foreign students. All applicants must submit 2 letters of recommendation at the time of application.

### Transfer of Credits

The transfer of credits to meet the requirements of the MS or PhD is not automatic. The student must petition the Graduate Program Chairman, certifying that the transfers make programmatic sense and that the courses to be transferred are equivalent in rigor and scholastic content to graduate-level (600-level) courses offered at the University of Hawai'i. 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, 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 adviser. If a faculty adviser has not been selected, the Graduate Chairman or his representative will perform this function. The selection of an adviser must be made before the end of the first semester in residence. The adviser, with the approval of the Graduate Chairman, shall guide the student on course selection matters, insure progression in the program, and advise the student until the permanent Graduate Program Committee is established.

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

## Master's Degree

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

### Requirements

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

Plan A students must complete a minimum of 24 credit hours of course work and 6 credit hours of thesis preparation. A final oral examination is required. For Plan B students must complete a minimum of 30 credit hours, including a minimum of 18 credit hours earned in courses numbered 600 to 798 of which a majority must be in Tropical Plant and Soil Sciences. A maximum of 6 credit hours (Plan B) or 2 credit hours (Plan A) in TPSS 699 may be credited towards the 30 credit hours applied.

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

## Doctoral Degree

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

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

## Requirements

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

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

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

## Courses Available for Each Option

### Tropical Plant and Soil Sciences

- TPSS 500 Master's Plan B/C Studies
- TPSS 601 Crop Modeling
- TPSS 603 Experimental Design
- TPSS 604 Advanced Soil Microbiology

- TPSS 610 Mineral Nutrition Tropical Crops
- TPSS 614 Cellular Genetics of Crops
- TPSS 615 Quantitative Genetics
- TPSS 640 Advanced Soil Chemistry
- TPSS 650 Advanced Soil Fertility
- TPSS 651 Techniques of Plant/Soil Analysis
- TPSS 654 Communications in Agriculture
- TPSS 667 Graduate Seminar
- TPSS 674 Plant Growth & Development
- TPSS 699 Directed Research
- TPSS 700 Thesis Research
- TPSS 711 Special Topics
- TPSS 800 Dissertation Research
- MBBE 620 Plant Biochemistry
- MBBE 670 Plant Cell Physiology
- MBBE 673 Organization and Expression of the Plant Genome
- MBBE 680 Methods in Plant Molecular Biology

### Tropical Plant and Soil Sciences - Horticulture

- TPSS 500 Master's Plan B/C Studies
- TPSS 601 Crop Modeling
- TPSS 603 Experimental Design
- TPSS 604 Advanced Soil Microbiology
- TPSS 610 Mineral Nutrition Tropical Crops
- TPSS 614 Cellular Genetics of Crops
- TPSS 615 Quantitative Genetics
- TPSS 630 Advanced Perishable Marketing
- TPSS 631 International Perishable Marketing
- TPSS 640 Advanced Soil Chemistry
- TPSS 650 Advanced Soil Fertility
- TPSS 654 Communications in Agriculture
- TPSS 667 Graduate Seminar
- TPSS 664 Orchidology
- TPSS 674 Plant Growth & Development
- TPSS 699 Directed Research
- TPSS 700 Thesis Research
- TPSS 711 Special Topics
- TPSS 800 Dissertation Research