

Graduate Program in Molecular Biosciences and Bioengineering

History

The Department of Molecular Biosciences and Bioengineering (MBBE) was established in 1999 as result of a reorganization within the College of Tropical Agriculture and Human Resources (CTAHR). Most faculty in MBBE came from three original CTAHR departments, Plant Molecular Physiology (PMP), Environmental Biochemistry, and Biosystems Engineering. Among these three departments, only PMP had a graduate program that offered both PhD and MS degrees. The PMP Graduate Program started in 1985 and focused primarily on plant biology and biotechnology.

After the formation of the MBBE department, the PMP Graduate Program was reorganized, expanded and renamed as the Graduate Program in Molecular Biosciences and Bioengineering in 2000. The scope of the MBBE Graduate Program was widened to include molecular biology, biochemistry, bioinformatics, cell biology, biotechnology, and bioengineering aspects of plant science, tropical agriculture, aquaculture, environmental bioremediation, bioengineering and biomedical sciences.

With the expansion of the scope of the graduate program, many other faculty from other UHM departments and scientists from other scientific institutes Hawaii joined the MBBE Graduate Program as co-operating and affiliate graduate faculty. The number of students also started to increase over the years. A new set of guidelines and requirements has been developed to maintain a high standard of the program. Currently, many MBBE graduate students are supervised by faculty from John A. Burns School of Medicine, Cancer Research Center, Pacific Biomedical Research Center, Queens Medical Center, Hawaii Agricultural Research Center, Oceanic Institute, Sea Grant College Program, School of Ocean and Earth Science and Technology, College of Engineering and several departments including Microbiology, Zoology, Human nutrition, Food and Animal Sciences, and Plant and Environmental Protection Sciences. Thus, MBBE became an interdisciplinary graduate program involving tropical agriculture, natural sciences, engineering and biomedical sciences.

Graduate Program in Molecular Biosciences & Bioengineering (MBBE)

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, biomedical science and bioengineering. Many MBBE graduate students are supervised and supported by cooperating and affiliate graduate faculty from John A. Burns School of Medicine, Cancer Research Center, Pacific Biomedical Research Center, Hawaii Agricultural Research Center, Sea Grant College Program, School of Ocean and Earth Science and Technology, College of Engineering and several departments including Microbiology, Zoology, Human nutrition, Food and Animal Sciences, and Plant and Environmental Protection Sciences.

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School of Ocean and Earth Science and Technology, College of Engineering and several departments including Microbiology, Zoology, Human nutrition, Food and Animal Sciences, and Plant and Environmental Protection Sciences. Thus, MBBE became an interdisciplinary graduate program involving tropical agriculture, natural sciences, engineering and biomedical sciences.

Entrance Requirements

- Minimum qualifications for admission 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 of the Graduate Division. Foreign students must also submit TOEFL scores (see Graduate Bulletin for exceptions). A minimum TOEFL score of 100 in internet-based test is required.
- All applicants are expected to have completed courses or equivalents in physics, chemistry, basic biology, genetics, biochemistry, physiology and one additional upper division course in cellular or molecular biology. While not a requirement, physical chemistry is highly recommended. Students may be accepted with deficiencies in one or more of these areas, however deficiencies must be made up during the first year as a graduate student. Such courses may not be used for graduate credit.

General guidelines and requirements for PhD degree in MBBE

1. **A temporary committee:** Graduate Chair appoints a temporary committee for each PhD student. The committee comprises the student's supervisor (major advisor), Graduate Chair, and a faculty member. The committee advises on course work and other academic and research related matters.
2. **Course work.** Students are required to take a minimum of three high-level courses and MBBE401 (Molecular Biotechnology). The courses must be pre-approved by the major advisor and Graduate Chair. Graduate students are encouraged to take one credit seminar (MBBE 610 or equivalent) each academic year. They require at least two seminar credits for PhD degree. The dissertation proposal or defense seminar cannot be used to meet this requirement.

3. **Two-page proposal.** Students need to discuss with their major advisors about their research projects and write a two-page proposal. The proposal must be submitted to the Graduate Chair within the first semester. The proposal should have the following sections: (i) Introduction (background and justification), objectives, and approach. A sample proposal is attached at the end of this section. If the scope and objectives of the project are changed or modified later, the temporary committee should be informed and a copy of the revised proposal should be submitted to the Graduate Chair.
4. **Qualifying exam:** PhD students have to take a qualifying exam within the first, second or third semester. As a part of this exam, students are asked to write a manuscript from the results obtained within the first one or two semesters.
5. **Permanent committee:** After completing the qualifying exam, a PhD student can form a permanent committee in consultation with his supervisor and the Graduate Chair.
6. **Presentation in a symposium:** Students are encouraged to make a poster presentation in the CTAHR symposium in the first year. They must make a presentation the CTAHR symposium or another UH symposium in the second year and should continue to make presentations in subsequent years until graduation.
7. **Other presentations:** Students are encouraged to make oral and poster presentations in other national and international conferences. A number of travel scholarships are available from the Graduate Student Organizations. Often the supervisors provide funds for student travel. Students can also make presentations in a number of research symposia organized at the UHM campus. These include Tester Symposium, Microbiology Symposium, and BioMed Symposium.
8. **The first manuscript:** Students should try to complete the manuscript that was started as a part of the qualifying exam and get it published as soon as possible.
9. **Committee meetings:** Students should meet at least once a year with the committee.
10. **Proposal seminar:** There should be frequent discussion between the student and the major advisor about the progress and direction of research. When a student and the major advisor both agree that the project is going well and there are some good data, the student may be allowed to write a full proposal and then present a proposal seminar. All graduate faculty and students are invited to the proposal seminars.

Seminar notice must be posted in appropriate places in the department and other important places one week before the seminar. Seminar notice must also be sent by email to all MBBE graduate faculty and students. A proposal seminar must not be delayed beyond three years. If it is delayed beyond three years, the Graduate Chair will discuss with the committee and consider transferring the student to the MS program. Please see below for guidelines on how to present a proposal seminar.

11. **Revision of dissertation proposal.** Sometimes, a project may not go as expected and run into unexpected problems. Under such a situation, the project may have to take a new direction and some of the objectives may have to be modified. The student should invite a committee meeting and present a revised proposal.
12. **Comprehensive exam:** It is an oral exam given by the committee and the Graduate Chair. The Graduate Chair or a representative appointed by him serves as the moderator for the exam. The committee will ensure that the student has learnt molecular biosciences or bioengineering and mastered the subject well. The comprehensive exam must not be delayed beyond three years. If it is delayed beyond three years, the Graduate Chair will discuss with the committee and consider transferring the student to MS program.
13. **Review of literature:** The students are encouraged to conduct an extensive literature review related to his/her research subject. He/she should discuss with his/her supervisor about the main focus of the “review of literature” chapter of his/her dissertation. This must be completed and forwarded to the committee within the first three years.
14. **Publications:** Publications are essential requirements of a PhD degree in MBBE. Students are encouraged to publish several papers in refereed journals. There must be at least one publication as the first author in a standard refereed journal. Only under an exceptional situation, where research subject is very problematic, and the supervisor assures and convinces the committee and the Graduate Chair that a publication is forthcoming, a student may be considered for graduation without a publication on the day of defense. Please see below to understand how the “Department of Molecular Biosciences and Bioengineering” address should appear in the publications.
15. **Submission of dissertation to the committee:** Students are encouraged to write and submit the ‘Review of Literature’ chapter to the committee well in advance, preferably one year before submitting the complete dissertation. They can also write the chapters ‘Introduction’ and ‘Materials and Method’ in advance. All chapters of the dissertation must be first submitted to and corrected by the major advisor before submitting to the

rest of the committee. The committee members may refuse to read the chapters if these were not previously read, corrected and approved by the major advisor.

16. **Final dissertation defense:** The final dissertation defense seminar is perhaps the most important event for PhD. Therefore, a student must prepare well for this presentation. A student must get approval of the major advisor and the committee for presenting a defense seminar. The Graduate Division must be notified in advance by the student through the Graduate Chair about the date, time and place of dissertation defense. Graduate faculty and students must be invited to the defense seminar. Please see below for the general guidelines on preparing a dissertation/thesis defense announcement flyer and presenting a defense seminar in MBBE. Seminar notice must be posted in appropriate places in the department and other important places one week before the seminar. Seminar notice must also be sent by email to all MBBE graduate faculty and students.
17. **Citing “Department of Molecular Biosciences & Bioengineering” in publications:** Students who work under the supervision of co-operating or affiliate Graduate Faculty in a laboratory outside of the MBBE department should also cite “Department of Molecular Biosciences & Bioengineering” in their publications, at least as the second address. In this case, the address and affiliation of the supervisor’s laboratory can be the primary address. For example:

M. Eustice^{1,2}, Qingyi Yu, C.W. Lai, S. Hou, J. Thimmapuram, L. Liu, M. Alam, P.H. Moore¹, G.G. Presting, R. Ming¹. 2008. Development and application of microsatellite markers for genomic analysis of papaya. *Tree Genetics and Genomics* 4:333-341.

¹, Hawaii Agriculture Research Center, Aiea, HI 96701

², Department of Molecular Biosciences and Bioengineering, University of Hawaii at Manoa, Honolulu, HI 96822

List of approved courses for MBBE graduate students

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

400-level courses:

- MBBE 401 Molecular Biotechnology
- MBBE402 Principles of Biochemistry
- MBBE405 Marine Genomics and Biotechnology
- MBBE406 Cellular Biology
- MBBE412 Environmental Biochemistry
- MBBE483 Introduction to Bioinformatics Topics for Biologists

600-level courses

- MBBE 601 Molecular Cell Biology
- MBBE 620 Plant Biochemistry
- MBBE 621 Metabolic Engineering
- MBBE 625 Biosensors: Principles and Applications
- MBBE 651 Signal Transduction and Regulation of Gene Transcription
- MBBE 680 Methods in Plant Molecular Biology
- MBBE 683 Advance Bioinformatics Topics in Biology
- MBBE 687 Advanced Lab Techniques
- BE 604 Aquaculture Systems
- BE 606 Instrumentation and Measurement
- BE 622 Experimental Methods in Cause-Effect Modeling
- BE 625 Biosensors: Principles and Applications
- BE 634 Biological Treatment
- BE 638 Biosystems Modeling
- BE 648 Biosystems Simulation
- BE 660 Bioseparation processes
- CHEM 633 Molecular Spectroscopy
- PEPS 646 Plant Bacterial Interactions
- PEPS 630 Plant Virology
- PEPS 681 Pesticide toxicology
- BOT 674 Plant Growth and Development

BOT 669 Molecular Systematics and Evolution
CMB 621 Cell Molecular Biology I
CMB 622 Cell Molecular Biology II
CMB 680 Molecular Genetics
MICR 671 Advanced Microbial Genetics
MICR 632 Advanced Microbial Physiology
MICR 625 Advanced Immunology
TPSS 604 Advanced Soil Microbiology
TPSS 614 Cellular Genetics of Crops
TPSS 640 Tissue Culture
OCN 653 Methods in Microbiology Oceanography

Guidelines for preparing a proposal seminar

- 1. What is the main idea of your research ?** Immediately after the title slide, the main idea must be presented in a simple language, so that everyone in the audience can understand what the research is about. Here you describe what the overall goal is and what you want to invent, discover or develop.
- 2. Next, you must give a good justification for your research.** Why is this research important ? Why do you need to invest your time and public funds for this research ?
- 3. What is already known ?** You are not required to provide an extensive review of literature. However, you must tell briefly what is known in this field.
- 4. What is not known ?** After telling briefly what is already known, you have to emphasize what is not known. This should connect you with the specific objectives.
- 5. Hypotheses:** You may present your hypotheses here or tie them together with specific objectives (below).
- 6. Specific objectives:** Generally, there should be two or more specific objectives. Three is a good number.
- 7. Specific objective 1.** Describe how you will accomplish this. Show flow charts if needed. Explain briefly important methods and experiments for this objective.
- 8. Specific objective 2.** Describe in the same way as for objective 1.
- 9. Specific objective 3.** Describe as for objectives 1 and 2.
- 10. Progress to date:** Describe your results so far for each of the objectives. You may not have results for all objectives. You must present convincing results for at least one objective (see below).
- 11.** If you have a lot of results, show only the most important results. Discuss with your supervisor about your most important results. Other results must be available for presentation, if someone asks.
- 12. Explain your results slowly.** Make sure that you provide interpretations of your results. Mere presentation of the results will not be enough. You have to explain what these results mean and how they relate to the objectives.

13. Timetable for completion. Show a timetable for rest of the experiments.

14. Discussion with your supervisor: It is essential that you show your slides and discuss with your supervisor at least one week prior to your presentation. It is also important to make the presentation before your supervisor and your colleagues in the laboratory. Listen to their criticism and try to improve your presentation. Your research subject may be very complicated and many in the audience may not understand some details or certain slides. However, all scientists and MBBE graduate students who come to attend your presentation must be able to understand the main idea and the important points.

Guidelines for preparing MS/PhD Defense seminar

Seminar notice must be posted in appropriate places in the department and other important places one week before the seminar. Seminar notice must also be sent by email to all MBBE graduate faculty and students.

For both proposal and defense seminars, you may assume that people in the audience have at least a BS degree and some background in biological sciences. That does not mean that everyone will be able to understand everything you present. There can be some high-level experiments that can be understood only by people trained in your research area. However, you should make the best efforts to make at least half of your presentation understandable to most people in the MBBE audience. It does not matter whether you are working on bioinformatics, cancer research, bioengineering, plant molecular biology or any other branches of molecular biosciences or bioengineering, you have to make at least 50% of your presentation understandable to most people in the audience. The following are the guidelines for preparing a defense seminar.

1. Discuss with your supervisor. He/she will help you to make difficult things easy.
2. As you progress in your research, try to make as many presentations as possible, keeping in mind that you are preparing for your final presentation.
3. Explain to your friends, parents, colleagues and others, whenever possible, what your work is about.
4. Do not show too many slides in your final presentation. If you have too many results, you do not have to present all. Present only the most important and most relevant results. Again, discuss with your supervisor about it.

5. Make a powerpoint presentation in front of your supervisor and your lab colleagues at least 10 days prior to your final presentation. Ask them for criticism and try to improve. If necessary, make another presentation before your supervisor 3-4 days prior to your final presentation.
6. **Title slide and a summary preview:** After reading the title, give a well-prepared speech for about 3-5 min describing in simple language what your research is about. Some points that can be addressed here are: how this research started, the most important findings (without details), benefits of these findings, and most importantly how you gained insight, experience, and expertise in research. You have to express your excitement for your work. This is like giving a preview of your presentation in simple words. This will make the audience interested in your presentation. This will also serve as a warm-up for your data presentation.
7. **The problem.** Describe the problem that your research addressed in one or more slides.
8. **Justifications for your work:** Why did you invest 3-5 years of your life for addressing the above problem ? Why are these time and money investments justified ? (at least one slide).
9. **What was already known when you started ?** You may show a number of slides to present a brief review of literature. Discuss with your supervisor about specifics. This must be short. The review of literature must not be dull, it must be connected well with the problem.
10. **Overall goal of your research** (one slide): State how you addressed the problem.
11. **Specific objectives:** Dissect the overall goal into specific doable objectives (one slide).
12. **Objective 1.** State the objective 1 and the associated hypothesis (one slide). At this stage do not rush. In about one min, try to give a simplified preview of the methods and experiments you conducted in this objective. You should have a well-prepared 1 min speech here. This will help to maintain attention of the audience on your work.
13. **Experiments in objective 1.** Using a number of slides, describe the experiments and results for objective 1. You may show short flowcharts to describe methods. Whenever you present some results with tables or graphs, give enough interpretations. Always try to connect results with the problem.

14. **Objectives 2 and 3.** Present in the same way as for objective 1. Do not forget to give a 1 min simplified preview of experiments for each objective before going into details.
15. At the end, remind the audience about the problem you wanted address and how your results addressed some questions. Here again you need to face the audience and stop depending on your slides. Tell briefly (in about 1 min) the highlights of your work.

Guidelines for preparing dissertation/thesis defense announcement flyer

1. Take a page in landscape page set-up and divide into two columns. Then fold the paper into half. This will make four half pages (both sides) from a standard A4 size paper. You may use a slightly thick paper.
2. Write your announcement in the format shown in the attached page. Briefly, in the front page, write your dissertation/thesis title, your name etc. In the second page, write the names of your committee members, your publications and future plan. In the third page, provide an abstract of your dissertation/thesis. You may include manuscripts in preparation also under your publications.
3. Prepare this at least one week before the presentation, get your major advisor's approval and send three copies to the Graduate Chair.
4. If you would like Graduate Chair to send these copies to your previous mentors and your biology or chemistry teachers who helped you to come to the MBBE Graduate Program, please provide their addresses.
5. Print it on color papers. Put on the notice board, send to different people as invitations and distribute copies at the time of presentation. Send copies to all those people whom you acknowledge in your dissertation/thesis.

An example of defense seminar announcement flyer (see 3 pages)
(Print in the landscape orientation on both sides of an A4 paper in two columns)

ORAL PUBLIC EXAMINATION
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

**Functions of *mid* and *pyd* genes required for mimosine
degradation by *Rhizobium* sp. strain TAL1145**

Jonathan David Awaya

2:15 PM
October 13, 2005
Agricultural Science Building, Room 219

Department of Molecular Biosciences and Bioengineering
University of Hawaii at Manoa

COMMITTEE MEMBERS

Dr. Dulal Borthakur (Chair)
Dr. Sean Callahan
Dr. Tung Hoang
Dr. John Hu
Dr. Qing Li

PUBLICATIONS

1. Awaya JD, Fox PM, Borthakur D (2005) *pyd* genes of *Rhizobium* sp. strain TAL1145 are required for degradation of 3-hydroxy-4-pyridone, an aromatic intermediate in mimosine metabolism. *J. Bacteriol.* 187 (13): 4480-4487.
2. Awaya J, Fox PM and Borthakur D (2003) Genes encoding a fructose-1,6-bisphosphate aldolase and a fructose-1,6-bisphosphatase are present within the gene cluster for mimosine degradation in *Rhizobium* sp. strain TAL1145. *Plant Soil* 257: 11-18.
3. Awaya J, Walton C and Borthakur D. The *pydA-pydB* fusion gene produces an active dioxygenase-hydrolase protein in *Rhizobium* and *Escherichia coli* that degrades 3-hydroxy-4-pyridone, an intermediate of mimosine metabolism (manuscript in preparation).

FUTURE PLAN

Postdoctoral research at Notre Dame starting on
February 1, 2006

ABSTRACT

Mimosine and 3-hydroxy-4-pyridone (HP) are toxic aromatic compounds produced in tree-legume leucaena (*Leucaena leucocephala*). These can be degraded by some leucaena-nodulating *Rhizobium* strains, such as TAL1145. Previously, a cosmid clone, pUHR263, containing the *mid* and *pyd* genes for mimosine and HP degradation, was isolated from a clone library of TAL1145. The aim of this project was to identify genes for mimosine and HP degradation in pUHR263 and determine their functions. Mimosine degradation by *Rhizobium* involves at least two major steps; in the first step mimosine is degraded to HP, which is then converted to pyruvate, formate and ammonia in the second step. Two structural genes, *pydA* and *pydB*, encode a *meta*-cleavage dioxygenase and a hydrolase, respectively. *pydA* and *pydB* are required for degradation of HP, and *pydC*, *pydD* and *pydE* encode proteins of an ABC-transport system involved in the uptake of HP by TAL1145. *pydA*, *pydB*, *pydC*, *pydD*, and *pydE* are induced by HP, although *pydA* and *pydB* show low levels of expression in the absence of HP. *pydA* and *pydB* are cotranscribed while *pydC*, *pydD*, and *pydE* are each transcribed from separate promoters. *pydR* is located upstream of the *pyd* genes and encodes a transcriptional regulator for the activation of *pydA* and *pydB* in the presence of HP. Elucidation of the HP degradation pathway in *Rhizobium sp.* strain TAL1145 may provide a useful strategy to genetically engineer leucaena and rhizosphere bacteria to disrupt the biosynthesis of mimosine and for bioremediation of aromatic toxins, respectively.

(End of the defense seminar announcement flyer)

Graduate Faculty

HARRY AKO, PhD

Specialization/research: biochemistry, aquaculture;

Professor

Department of Molecular Biosciences & Bioengineering

University of Hawaii at Manoa

1955 East-West Road, Ag. Science 218

Honolulu, HI 96822, USA

Tel: 808-956-6600; Fax: 808-956-3542

Email: hako@hawaii.edu;

<http://www.ctahr.hawaii.edu/mbbe/faculty/ako.html>

JON-PAUL BINGHAM, PhD

Specialization/research: Marine peptide biochemistry, biodegradation;

Assistant Professor

Department of Molecular Biosciences & Bioengineering

University of Hawaii at Manoa

1955 East-West Road, Ag. Science 218

Honolulu, HI 96822, USA

Tel: 808-956-6600; Fax: 808-956-3542

Email: <jbingham@hawaii.edu>

<http://www.ctahr.hawaii.edu/mbbe/faculty/bingham.html>

DULAL BORTHAKUR, PhD

Specialization/research: molecular biology and biotechnology, plant-microbe interactions, biodegradation, recombinant vaccine;

Professor

Department of Molecular Biosciences & Bioengineering

University of Hawaii at Manoa

1955 East-West Road, Ag. Science 218

Honolulu, HI 96822, USA

Tel: 808-956-6600; Fax: 808-956-3542

Email: dulal@hawaii.edu;

<http://www.ctahr.hawaii.edu/mbbe/faculty/borthakur.html>

DAVID CHRISTOPHER, PhD

Specialization/research: plant molecular and cellular biology, functional genomics, biotechnology;

Professor

Department of Molecular Biosciences & Bioengineering

University of Hawaii at Manoa

1955 East-West Road, Ag. Science 218

Honolulu, HI 96822, USA

Tel: 808-956-8550; Fax: 808-956-3542

Email: dchr@hawaii.edu;
<http://www.ctahr.hawaii.edu/mbbe/faculty/christopher.html>

DANIEL M. JENKINS, PhD
Specialization/research: biosensors and instrumentation;
Associate Professor
Department of Molecular Biosciences & Bioengineering
University of Hawaii at Manoa
1955 East-West Road, Ag. Science 218
Honolulu, HI 96822, USA
Tel: 808-956-6069; Fax: 808-956-3542
Email: danielje@hawaii.edu;
<http://www.ctahr.hawaii.edu/mbbe/faculty/jenkins.html>

SAMIR K. KHANAL, PhD
Specialization/research: Bioenergy and Biobased Products; Waste-to-Energy;
Assistant Professor
Department of Molecular Biosciences & Bioengineering
University of Hawaii at Manoa
1955 East-West Road, Ag. Science 218
Honolulu, HI 96822, USA
Tel: 808-956-3812; Fax: 808-956-3542
Email: khanal@hawaii.edu;
<http://www.ctahr.hawaii.edu/mbbe/faculty/khanal.html>

QING LI, PhD
Specialization/research: environmental biochemistry, biodegradation, proteomics;
Professor
Department of Molecular Biosciences & Bioengineering
University of Hawaii at Manoa
1955 East-West Road, Ag. Science 218
Honolulu, HI 96822, USA
Tel: 808-956-2011; Fax: 808-956-3542
Email: qingl@hawaii.edu;
<http://www.ctahr.hawaii.edu/mbbe/faculty/li.html>

PRATIBHA V. NERURKAR, PhD
Specialization/research: biochemistry of metabolic disorder and alternative
medicine;
Associate Professor
Department of Molecular Biosciences & Bioengineering
University of Hawaii at Manoa
1955 East-West Road, Ag. Science 218
Honolulu, HI 96822, USA

Tel: 808-956-9195; Fax: 808-956-3542
Email: pratibha@hawaii.edu;
<http://www.ctahr.hawaii.edu/mbbe/faculty/nerurkar.html>

GERNOT PRESTING, PhD
Specialization/research: bioinformatics, functional genomics;
Associate Professor
Department of Molecular Biosciences & Bioengineering
University of Hawaii at Manoa
1955 East-West Road, Ag. Science 218
Honolulu, HI 96822, USA
Tel: 808-956-8861; Fax: 808-956-3542
Email: gernot@hawaii.edu;
<http://www.ctahr.hawaii.edu/mbbe/faculty/presting.html>

WEI-WEN WINSTON SU, PhD
Specialization/research: biochemical engineering, plant cell culture, molecular biotechnology;
Professor
Department of Molecular Biosciences & Bioengineering
University of Hawaii at Manoa
1955 East-West Road, Ag. Science 218
Honolulu, HI 96822, USA
Tel: 808-956-3531; Fax: 808-956-3542
Email: wsu@hawaii.edu;
<http://www.ctahr.hawaii.edu/mbbe/faculty/su.html>

PING-YI YANG, PhD
Specialization/research: bioprocess technology, wastewater engineering;
Professor
Department of Molecular Biosciences & Bioengineering
University of Hawaii at Manoa
1955 East-West Road, Ag. Science 218
Honolulu, HI 96822, USA
Tel: 808-956-8459; Fax: 808-956-3542
Email: pingyi@hawaii.edu;
<http://www.ctahr.hawaii.edu/mbbe/faculty/yang.html>

Cooperating Graduate Faculty

JOHN S ALLEN III, PhD
Specialization: Biomedical engineering, Physical and Biological Acoustics, Bubble Dynamics and Cavitation
Associate Professor

Department of Mechanical Engineering
University of Hawaii-Manoa
2540 Dole Street
Honolulu, HI 96822
Email: alleniii@hawaii.edu

ANNE ALVAREZ, PhD
Specialization/research: plant-pathogen interactions, biocontrol of plant diseases;
Professor
Department of Plant and Environmental Protection Sciences
University of Hawaii at Manoa
3050 Maile Way
Honolulu, HI 96822, USA
Tel: 808-956-7764; Fax: 808-956-2832
Email: alvarez@hawaii.edu;
http://www.ctahr.hawaii.edu/peps/people/fac/profile_alvarez.htm

JOHN D AWAYA, PhD
Specialization: Biodegradation and bioremediation
Assistant Professor
Department of Biology
University of Hawaii at Hilo
200 W. Kawili St.
Hilo, HI 96720
Email: awayaj@hawaii.edu

ANDRÉ S. BACHMANN, PhD
Specialization/research: tumor growth and cell differentiation;
Assistant Professor
Cancer Research Center of Hawaii
University of Hawaii at Manoa
1236 Lauhala Street
Honolulu, Hawaii 96813, USA
Tel: 808-586-2962; Fax: 808-586-2970
Email: abachmann@crch.hawaii.edu;
<http://www.crch.org/ProfileBachmann.htm>

MICHELE CARBONE, MD, PhD
Specialization/research: Cancer biology;
Professor
Cancer Research Center of Hawaii
University of Hawaii at Manoa
651 Ilalo Street, BSB 231
Honolulu, Hawaii 96813, USA
Tel: 808-440-4596; Fax: 808-587-0742
Email: mcarbhone@crch.hawaii.edu;

<http://www.crch.org/ProfileCarbone.htm>

Leng Chee Chang, PhD

Specialization: protein kinase inhibitors, characterization of natural bioactive compounds, Traditional cultural medicines

Assistant Professor

Department of Pharmaceutical Sciences,

College of Pharmacy

University of Hawaii Hilo

34 Rainbow Drive,

Hilo, Hawaii 96720

Tel: (808)-933-2906; Fax: (808)-933-2974; E-mail:

Email: lengchee@hawaii.edu

SANDRA CHANG, PhD

Specialization/research: vaccine development, molecular immunology;

Department of Tropical Medicine, Medical Microbiology and Pharmacology

Professor

University of Hawaii at Manoa

Bioscience Building, Rm. 320H

651 Ilalo Street

Honolulu HI 96813

Tel: 808-692-1607; Cel:808-386-2158

Email: sandrac@hawaii.edu;

<http://jabsom.hawaii.edu/JABSOM/faculty/bio.php?facultyid=85>

GERT DE COUET, PhD

Specialization/research: molecular biology, invertebrate biology, biotechnology;

Professor

Department of Zoology, Keller Hall 305

University of Hawaii at Manoa

Honolulu, Hawaii 96813, USA

Tel: 808-956-9686; Fax: 808-956-9812

Email: couet@hawaii.edu; <http://www.hawaii.edu/zoology/faculty/decouet.htm>

MICHAEL DUNN, PhD

Specialization/research: molecular nutrition;

Associate Professor

Department of Human Nutrition, Food, and Animal Sciences

University of Hawai'i at Manoa

1955 East-West Road, Ag. Sci 216

Tel: 808-956-3837; Fax: 808-956-4024

Email: mdunn@hawaii.edu;

WAEL M. ELSHAMY, PhD

Specialization: Cancer biology, Metastatic Breast Cancer

Cancer Research Center of Hawaii
Assistant Professor
University of Hawaii at Manoa
651 Ilalo Street, BSB 231C
Honolulu, HI, 96813
808-440-4580 (Phone)
808-587-0790 (Fax)
Email: welshamy@crch.hawaii.edu

DAVID C. FRITZINGER, Ph.D.
Specialization: Natural Products and Cancer Biology
Associate Researcher
Cancer Research Center of Hawaii
1236 Lauhala St.
Honolulu, HI 96813
Tel: (808) 586-2966
Fax: (808) 586-2970
Cell: (808) 282-8843
Email: dfritzin@crch.hawaii.edu

RUTH D. GATES, PhD
Specialization: the regulation and de-stabilization of coral/dinoflagellate symbioses, and the evolution and development of animal sensory systems.
Associate Researcher
Hawaii Institute of Marine Biology/SOEST
P.O. Box 1346, Kaneohe, HI 96744-1346
Tel: 808 236 7420 (office); 808 236 7493 (lab)
Fax: 808 236 7443
Email: rgates@hawaii.edu
<http://www.hawaii.edu/HIMB/Faculty/gates.html>

GODON GRAU, PhD
Specialization/research: marine biology;
Professor
Department of Zoology and Sea Grant Program, HIG 328
University of Hawaii at Manoa
Honolulu, Hawaii 96813, USA
Tel: 808-959-7031; Fax: 808-956-3014
Email: sgdir@hawaii.edu; <http://www.hawaii.edu/HIMB/Faculty/grau.html>

CHUNG-EUN HA, PhD
Specialization/research: biochemistry, Human Serum Albumin;
Associate Professor
Department of Native Hawaiian Health
University of Hawaii at Manoa
651 Ilalo Street, MEB306c

Honolulu HI 96813
Tel: 808- 692-1033; Fax:808-692-1254
Email: chungun@hawaii.edu; <http://www2.hawaii.edu/~chungun/>

TUNG HOANG, PhD
Specialization/research: molecular microbiology; bacterial pathogen;
Associate Professor
Department of Microbiology
University of Hawaii at Manoa, Snyder 308
Honolulu, HI 96822, USA
Tel: 808-956-4796; Fax: 808-956-5339
Email: tongh@hawaii.edu;
<http://www.hawaii.edu/microbiology/Hoang/index.htm>

JOHN HU, PhD
Specialization/research: plant virology;
Professor
Department of Plant and Environmental Protection Sciences
University of Hawaii at Manoa
3050 Maile Way
Honolulu, HI 96822, USA
Tel: 808-956-7281; Fax: 808-956-2832
Email: johnhu@hawaii.edu; <http://www2.hawaii.edu/~johnhu/>

YONG-SOO KIM, PhD
Specialization/research: animal biotechnology;
Associate Professor
Department of Human Nutrition, Food, and Animal Sciences
University of Hawai'i at Manoa
1955 East-West Road, Ag. Sci 216
Tel: 808-956-8335; Fax: 808-956-4024
Email: ykim@hawaii.edu;

DARREN T. LERNER, PhD
Specialization: Marine biology
Associate Director
University of Hawaii Sea Grant College Program
2525 Correa Rd, HIG 238
Honolulu, HI 96822
Tel: (808) 956-7031
Email: lerner@hawaii.edu

PINGSUN LEUNG, PhD
Specialization/research: bioproduction economics, aquaculture, fisheries;
Professor
Department of Natural Resource and Environmental Management

University of Hawaii at Manoa
1910 East-West Road, Ag. Serman 101
Honolulu, HI 96822, USA
Tel: 808-956-8562; Fax: 808-956-3542
Email: psleung@hawaii.edu;
<http://www.ctahr.hawaii.edu/mbbe/faculty/leung.html>

CLARK C. LIU, PhD
Specialization/research: bioengineering;
Professor
Department of Civil and Environmental Engineering
University of Hawaii at Manoa
POST 203-F, Honolulu, HI 96822
Tel: 808-956-7658; Fax: 808-956-5014
Email: clarkliu@hawaii.edu; <http://www.cee.hawaii.edu/persons/liu/liu.htm>

PATRICIA S. LORENZO, PhD
Specialization/research: cancer biology;
Associate Professor
Cancer Research Center of Hawaii
University of Hawaii at Manoa
651 Ilalo Street, BSB 231
Honolulu, Hawaii 96813, USA
Tel: 808-586-5868; Fax: 808-587-0742
Email: plorenzo@crch.hawaii.edu; <http://www.crch.org/ProfileLorenzo.htm>

WILL C. MCCLATCHEY, PhD
Specialization/research: applied ethnobotany, medicinal plants;
Professor
Department of Botany
University of Hawaii at Manoa
3190 Maile Way, Honolulu, HI 96822
Tel: 808-956-6704; Fax: 808-956-3923;
Email: mcclatch@hawaii.edu;
<http://www.ctahr.hawaii.edu/mbbe/faculty/mcclatchey.html>

CLIFFORD W. MORDEN, PhD
Specialization/research: molecular systematics;
Associate Professor
Department of Botany
University of Hawaii at Manoa
3190 Maile Way, Honolulu, HI 96822
Tel: 808-956-9636; Fax: 808-956-3923;
Email: cmorden@hawaii.edu; <http://www.botany.hawaii.edu/faculty/morden/>

VIVEK NERURKAR, PhD

Specialization/research: molecular virology and epidemiology;
Professor
Department of Tropical Medicine, Medical Microbiology and Pharmacology
University of Hawaii at Manoa
Bioscience Building, BSB 325AA
651 Ilalo Street
Honolulu HI 96813
Tel: 808-692- 1668; Fax:808-692-1984
Email: nerurkar@pbrc.hawaii.edu;
<http://jabsom.hawaii.edu/JABSOM/faculty/bio.php?facultyid=535>

ROBERT NICHOLS, PhD
Specialization: Beta Amyloid and Presynaptic Nicotinic Receptors
Department of Cell & Molecular Biology
University of Hawai'i at Manoa
John A. Burns School of Medicine
651 Ilalo St., Honolulu, HI 96813
Tel: 808-692-1568
Email: robert.nichols@hawaii.edu

GUYLANE POISSON, PhD
Specialization: Bioinformatics
Assistant Professor
Information and Computer Science Department
University of Hawaii at Manoa
1680 East-West RD #310B
Honolulu HI 96822
Tel: 808-956-3496
Email: guylaine@hawaii.edu
<http://navet.ics.hawaii.edu/~poisson/BiL/index.html>

JOE RAMOS, PhD
Specialization/research: cancer biology;
Associate Professor
Cancer Research Center of Hawaii
University of Hawaii at Manoa
651 Ilalo Street, BSB 231
Honolulu, Hawaii 96813, USA
Tel: 808-564-5843; Fax: 808-587-0742; Cel: 808-389-6427;
Email: jramos@crch.hawaii.edu;
<http://www.crch.org/ProfileRamos.htm>

CITTARANJAN RAY, PhD
Specialization/research: ground water hydrology, bioremediation;
Professor

Department of Civil and Environmental Engineering and Water Resources
Research Center, University of Hawaii at Manoa, 2540 Dole Street, Honolulu, HI
96822.

Tel: 808-956-9652, Fax: 808-956-5014

Email: cray@hawaii.edu;

<http://www.cee.hawaii.edu/persons/ray/ray.htm>

RALPH SHOHEI, MD

Specialization/research: Molecular medicine;

Professor

Department of Medicine

University of Hawai'i at Manoa

651 Ilalo St., Bio-Sciences Building 217 , BSB-211D, Honolulu, HI 96813

Honolulu, HI 96813

Tel: 808-692-1469; Fax 808-692-1966

Email: shohet@hawaii.edu;

<http://www.hawaii.edu/shohet/>

ALEX J. STOKES, PhD

Specialization/research: cell biology;

Assistant Professor

Department of Medicine, JABSOM

University of Hawaii

Biosciences Building 320,

651 Ilalo Street, Honolulu, HI 96813

Tel: (808)-692-1633

Email: astokes@hawaii.edu

CLYDE TAMARU, PhD

Specialization/research: aquaculture;

Associate Researcher

Sea Grant Extension Service

2525 Correa Road, HIG 205

Honolulu, HI 96822

Tel: 808-956-2869 ; Fax: 808-956-2858

Email: ctamaru@hawaii.edu;

ANDRE THERIAULT, PhD

Specialization/research: nutrition, diabetes, and lipid metabolism;

Professor

Department of Medical Technology

University of Hawai'i at Manoa

Biomed C-206

Honolulu, HI 96822

Tel: 808-956-8632; Fax: 808-956-9084; Email: andret@hawaii.edu;

GUANGYI WANG, PhD
Specialization/research: marine microbial bioengineering and biotechnology;
Associate Professor
Department of Oceanography
University of Hawai'i at Manoa
Tel: 808-956-3744; Fax: 808-956-2336
Email: guangyi@hawaii.edu;
<http://www.soest.hawaii.edu/oceanography/faculty/wang.html>

ANGEL YANAGIHARA, PhD
Specialization/research: biochemistry, peptide toxins;
Assistant Researcher
University of Hawai'i at Manoa
Biomed A-204
Honolulu, HI 96822
Tel: 808-956-8328; Fax: 808-956-6984
Email: angel@pbrc.hawaii.edu; <http://www.pbrc.hawaii.edu/bln/angel/>

JINZENG YANG, PhD
Specialization/research: animal molecular biology and biotechnology;
Associate Professor
Department of Human Nutrition, Food, and Animal Sciences
University of Hawai'i at Manoa
1955 East-West Road, Ag. Sci 216
Tel: 808-956-6073; Fax: 808-956-4024
Email: jinzeng@hawaii.edu; <http://expertise.cos.com/cgi-bin/exp.cgi?id=1019320>

JIAN YU, PhD
Specialization/research: bioengineering, marine bioproduct development;
Associate Professor
Hawaii Natural Energy Institute,
School of Ocean & Earth Science & Technology
University of Hawaii at Manoa, Honolulu, Hawaii, USA
Tel: 808-- 956-5873; Fax: 808-956-2336
Email: jianyu@hawaii.edu;
<http://www.hnei.hawaii.edu/text/template.asp?userID=jianyu>

Affiliate Graduate Faculty

HENRIK H. ALBERT, PhD
Specialization/research: Plant molecular biology and biotechnology;
Pioneer Hi-Bred, 700A Bay Road, Redwood City, CA 94063
Tel: 650-298-3354
Email: henrik.albert@pioneer.com

PAUL H. MOORE, PhD

Specialization/research: sugarcane biotechnology, plant molecular biology;
USDA ARS Tropical Plant Pathology, Physiology, & Production Unit
Hawaii Agriculture Research Center
99-193 Aiea Heights Dr., Aiea, HI 96701
Tel: 808-486-5411; Fax: 808-486-5020
Email: paul.moore@ars.usda.gov;

RAY MING, PhD
Specialization/research: plant molecular biology;
Department of Plant Biology
University of Illinois at Urbana-Champaign
1201 W. Gregory Drive, 288 ERML, MC-051
Urbana, IL 61801
Tel: 217-333-1221; Fax: 217-244-1336
Email: rming@life.uiuc.edu;

SHAUN MOSS, PhD
Specialization/research: aquaculture;
The Oceanic Institute
41-202 Kalaniana'ole Hwy
Waimanalo, HI 96795
Tel: 808-259-3110; Fax: 808-259-9762
Email: smoss@oceanicinstitute.org;

MINGLI WANG, PhD
Specialization/research: plant molecular biology;
Hawaii Agriculture Research Center
99-193 Aiea Heights Drive, Aiea, HI 96701
Tel: 808-486-5389; Fax: (808) 486-5020
Email: mwang@harc-hspa.com;

QINGYI YU, PhD
Specialization/research: plant molecular biology;
Hawaii Agriculture Research Center
99-193 Aiea Heights Drive, Aiea, HI 96701
Tel: 808-486-5374; Fax: (808) 486-5020
Email: qyu@harc-hspa.com;

JUDY ZHU, PhD
Specialization/research: plant transformation, biotechnology;
Hawaii Agriculture Research Center
99-193 Aiea Heights Drive, HI 96701
Tel: 808-486-5376; Fax: (808) 486-5020 Aiea HI 96701
Email: jzhu@harc-hspa.com